TYPE I PROGRESS REPORT

For Period Ending 1 April 1973

A. Title of Investigation:

Evaluation of the Application of ERTS-1 Data to the Regional Land Use Planning Process, Proposal #058, Contract #NAS 5-21754.

B. GSFC Identification Number of Principal Investigator:

James L. Clapp, UN 040

C. Statement of Any Problems Impeding Progress of Investigation:

None at this time.

D. Discussion of Accomplishments During Reporting Period and Those Planned for Next Reporting Period:

To date, the project has received ERTS images from the following dates: August 9, 12, 27, 28, 29, 30, 31; September 14, 15, 16, 17, 18; October 1, 2, 4, 6, 20, 23; November 6, 24, 28, 29; December 13, 14, 15, 16, 17; January 1, 2, 4, 17, 18, 19, 20, 21; and February 4, 5, 7, 8, 9, 23, 25. These dates received are black and white images, bulk format. Additionally, we have now received bulk color composites ordered respectively for the dates August 9, 10, 12, September 14, and December 13.

As identified in previous progress reports, correlation with existing spatial data banks is a primary goal of this research. In order to examine different variables, two sample areas (each 300 square km.) were selected. Methodologies were developed to spatially compare interpretations from 1) ERTS imagery, 2) RB-57 imagery, and 3) conventional data sources (the existing data bank). The two sample areas represent varying natural and cultural conditions within the REMAP I computer data base (10,000 square kilometers - southeastern Wisconsin and described in previous progress reports). The sample areas will be identified as the "Sheboygan Sample Site" and the "Green Bay Sample Site", references to geographical locations in Wisconsin.

Figures 1-17 illustrate the results of these correlations. Due to changes in resource conditions, the same types of data were not always analyzed for each sample area. In the Green Bay sample area, the following data types were analyzed:

agriculture (see Figure 1)
escarpment (see Figure 2)
forest (see Figure 3)
Lake Michigan (see Figure 4)
lakes less than 50 acres (see Figure 5)
residential, urban and suburban (see Figure 6)
rivers (see Figure 7)
lakes (see Figure 8)
roads (see Figure 9)

In the Sheboygan sample, correlations were made with:

agriculture (see Figure 10)
forest (see Figure 11)
lakes (see Figure 12)
lakes less than 50 acres (see Figure 13)
open swamp (see Figure 14)
residential, urban and suburban (see Figure 15)
rivers (see Figure 16)
roads (see Figure 17)

Each of these figures depicts certain information about the data analyzed. The general format of the output includes: 1) project; 2) contract number; 3) research investigation group and group location; 4) name of sample test site; 5) data number and type; 6) spatial comparison which presents quantitative information about the extent and location of a given data type as interpreted from ERTS-1 imagery (A), RB-57 imagery (B), and from conventional sources - REMAP I data bank (C); 7) total acres as derived from each of the sources; 8) symbol representation of percent of occurrence of the given data type per one kilometer cell and range (i.e. · = 1-9% occurrence per kilometer cell, or * = 50-59% occurrence per kilometer cell); 9) occurrence per level for each of the three interpretations (ERTS [A], RB-57 [B],

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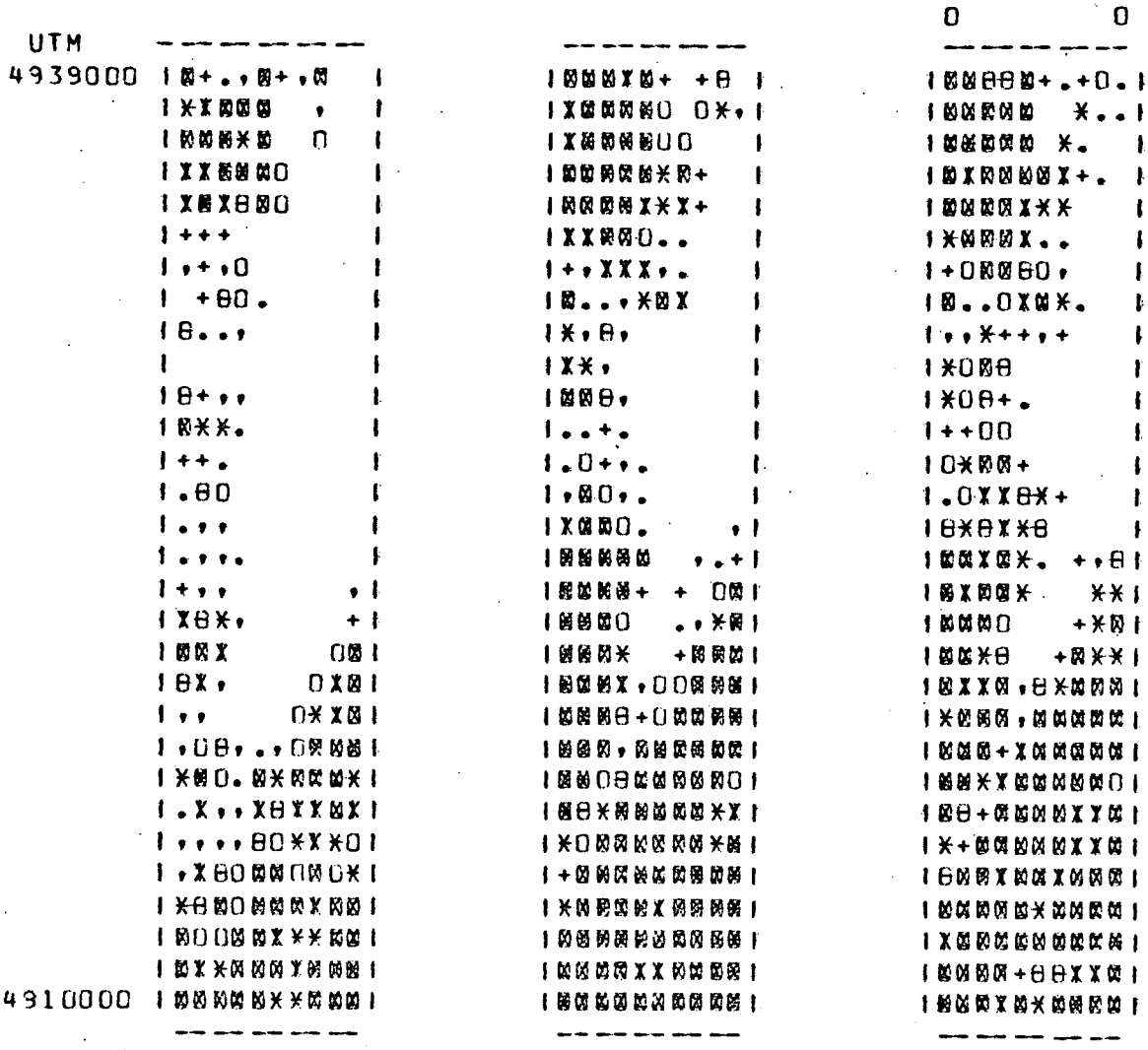
GREEN BAY TEST SITE
VARIABLE 63 AGRICULTURE

FIGURE 1



		A ERTS	B RB57	C REMAP I
TOT. ACRES		24391.24	39846.02	39371.78
LEVELS		1	2	3	4	5	6	7	8	9	10
SYMBOLS		. , + 0 @ * X									
RANGE (%)		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
OCCUR	A	13	29	12	20	12	18	21	21	26	12
	B	14	16	13	16	6	13	18	30	48	60
	C	14	7	19	12	16	27	24	50	64	9
ACRES	A	304.	1270.	852.	1964.	1371.	2569.	3520.	4063.	5644.	2836.
	B	284.	751.	902.	1507.	741.	1927.	3075.	5300.	10507.	14353.
	C	296.	338.	1356.	1163.	1988.	3962.	4142.	9858.	14136.	2132.

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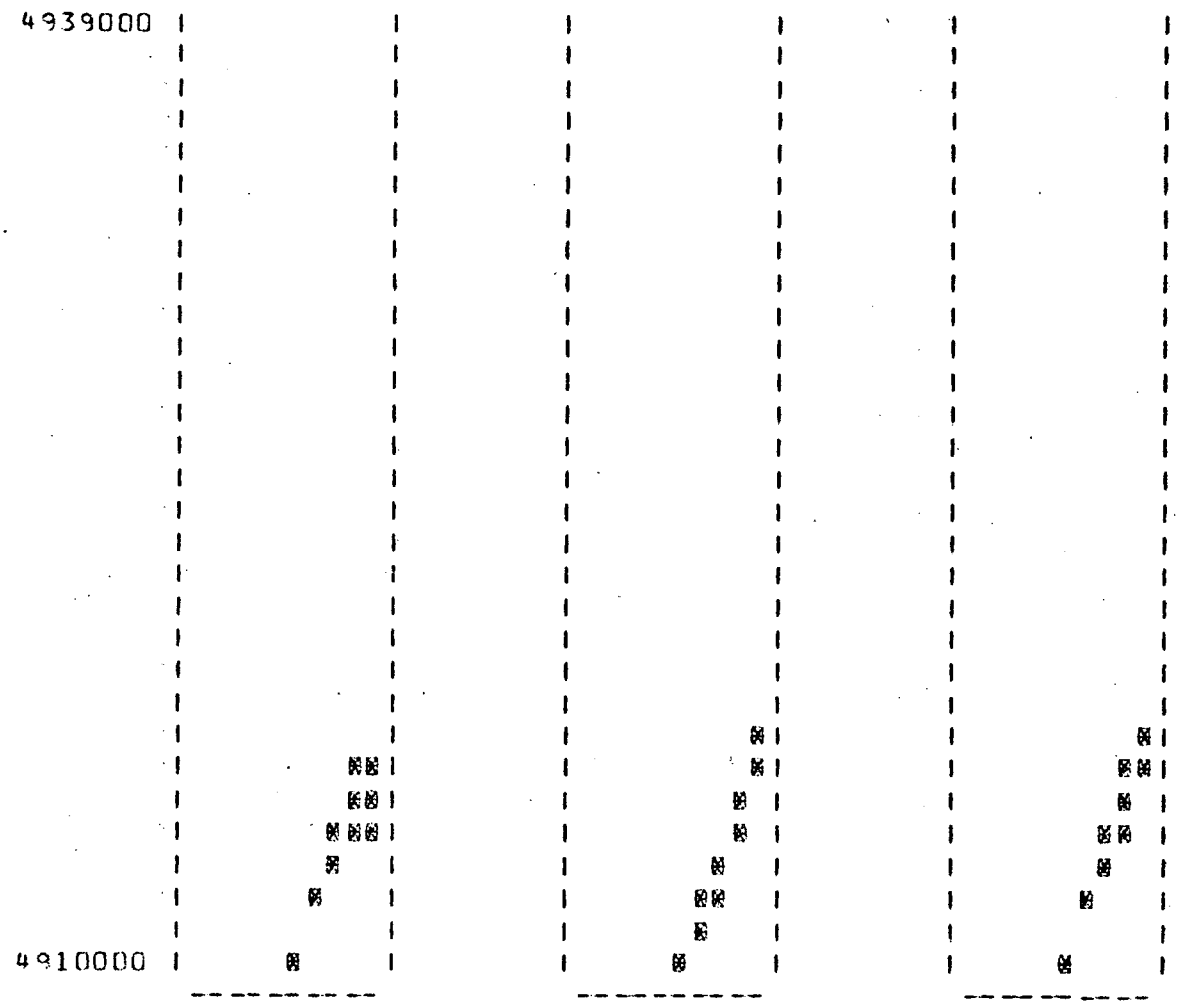
GREEN BAY TEST SITE
VARIABLE 13-11 ESCARPMENT

FIGURE 2



TOT. ACRES		2470.00			2223.00				2223.00		
LEVELS		1	2	3	4	5	6	7	8	9	10
SYMBOLS		.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	%%%%%	%%%%%
		.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	%%%%%	%%%%%
		.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	%%%%%	%%%%%
RANGE (%)		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
OCCUR	A	0	0	0	0	0	0	0	0	0	10
	B	0	0	0	0	0	0	0	0	0	9
	C	0	0	0	0	0	0	0	0	0	9
ACRES	A	0.	0.	0.	0.	0.	0.	0.	0.	0.	2470.
	B	0.	0.	0.	0.	0.	0.	0.	0.	0.	2223.
	C	0.	0.	0.	0.	0.	0.	0.	0.	0.	2223.

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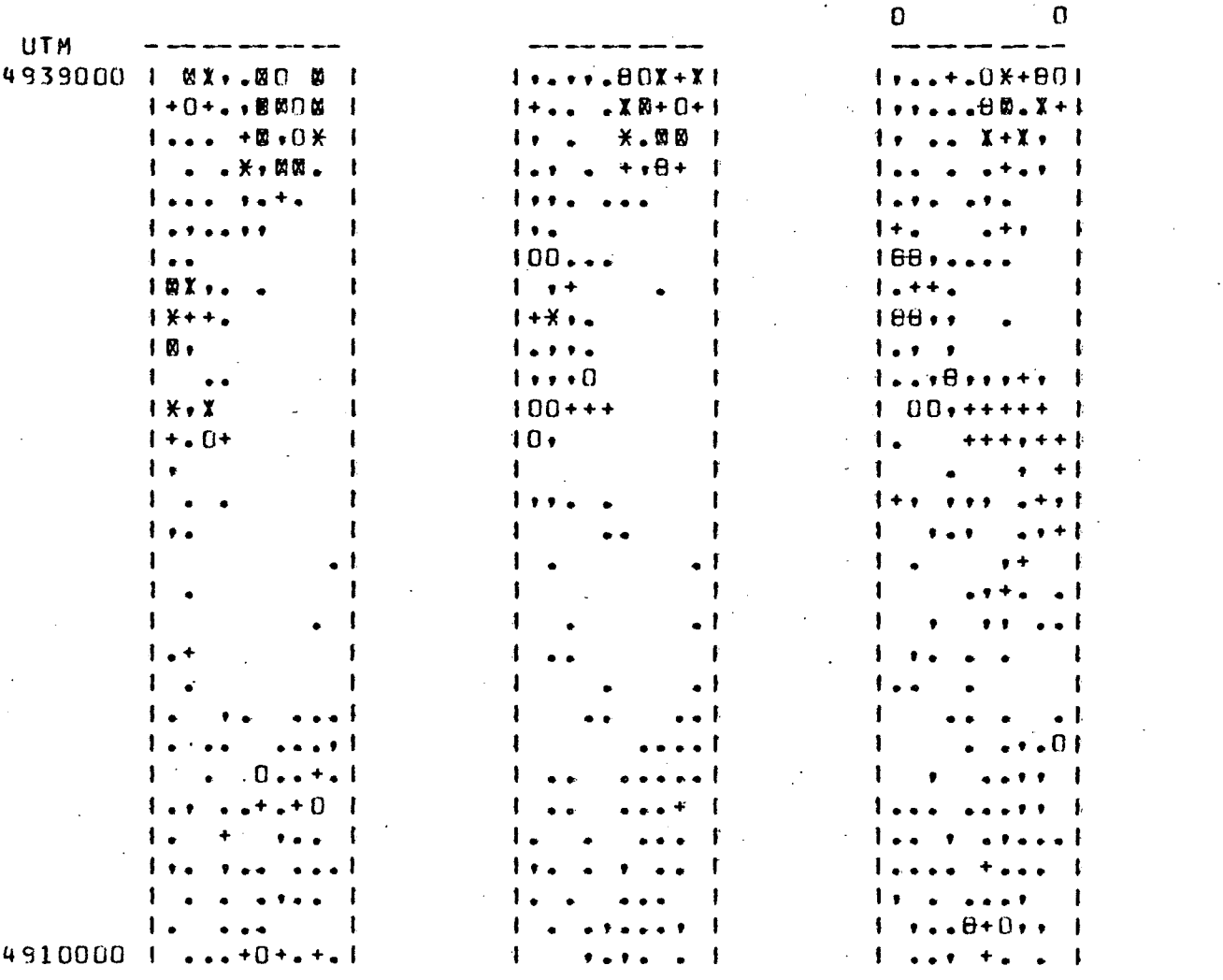
GREEN BAY TEST SITE
VARIABLE 24 + 25 FOREST

FIGURE 3



		A ERTS	B RB57	C REMAP I
TOT. ACRES		7637.24	5994.69	8543.73

LEVELS		1	2	3	4	5	6	7	8	9	10
SYMBOLS		.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	%%%%%	%%%%%
RANGE (%)		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
OCCUR	A	74	20	16	8	0	4	3	3	7	1
	B	75	25	12	8	2	2	3	2	1	0
	C	85	50	29	6	8	1	3	0	1	0
ACRES	A	1484.	909.	1124.	741.	0.	580.	482.	568.	1514.	235.
	B	1544.	1203.	864.	751.	230.	306.	482.	400.	215.	0.
	C	1751.	2282.	2102.	578.	946.	148.	504.	0.	232.	0.

ERTS-1 INVESTIGATION: CONTRACT # NAS 5-21754 FIGURE 4
ENVIRON. MONITORING AND ACQUISITION GROUP
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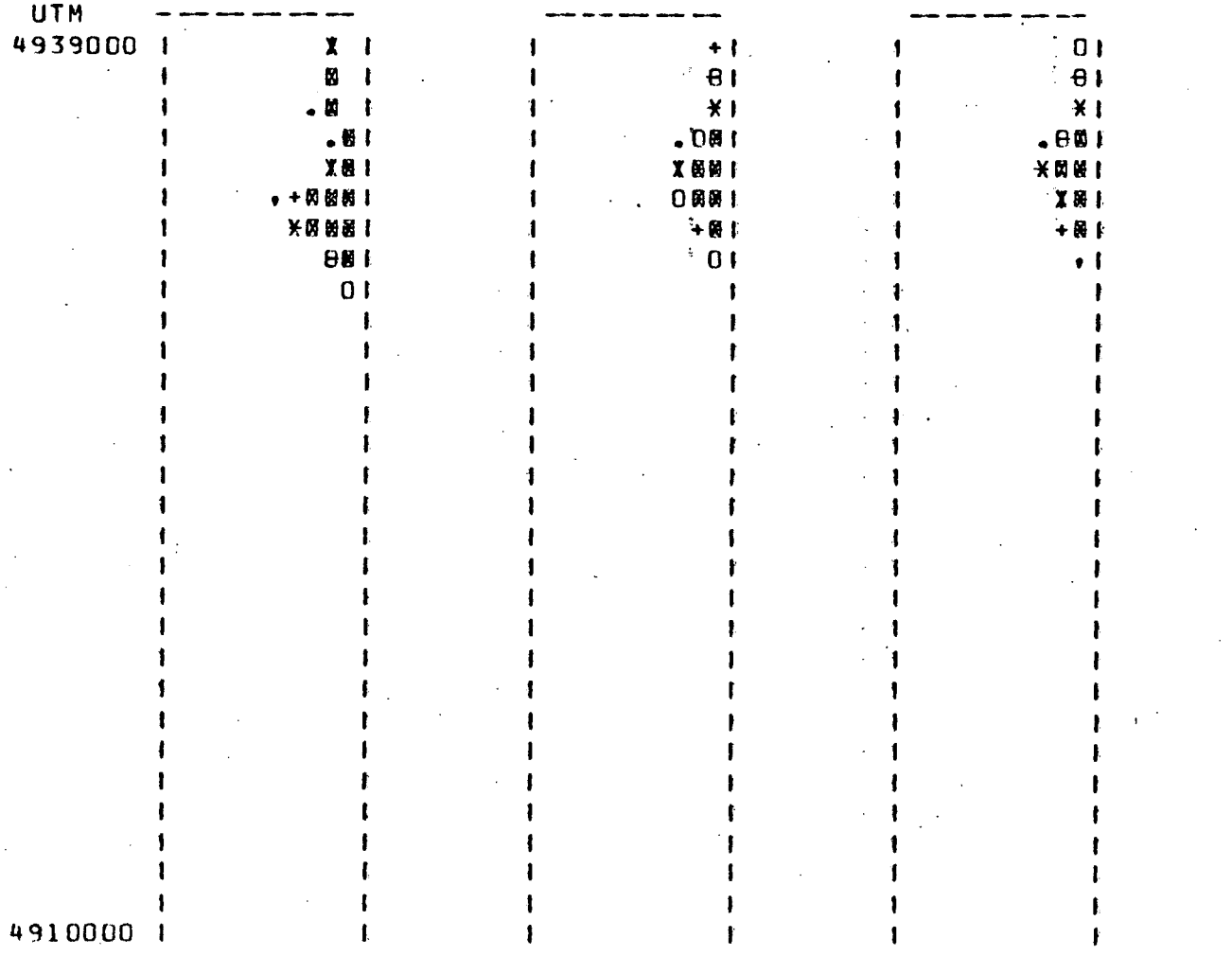
GREEN BAY TEST SITE
VARIABLE 22 LAKE MICHIGAN



		A ERTS	B RBS7	C REMAP I
TOT. ACRES		3356.73	2346.50	2099.50

LEVELS		1	2	3	4	5	6	7	8	9	10
SYMBOLS		.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	%%%%%	%%%%%
		.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	%%%%%	%%%%%
		.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	%%%%%	%%%%%
RANGE (%)		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
OCCUR	A	2	1	1	1	1	1	2	3	1	7
	B	1	0	2	3	1	1	1	0	0	6
	C	1	1	1	1	2	2	1	0	2	3
ACRES	A	37.	49.	74.	99.	111.	136.	333.	580.	227.	1709.
	B	27.	0.	165.	267.	111.	148.	173.	0.	0.	1455.
	C	20.	57.	62.	99.	230.	291.	173.	0.	445.	724.

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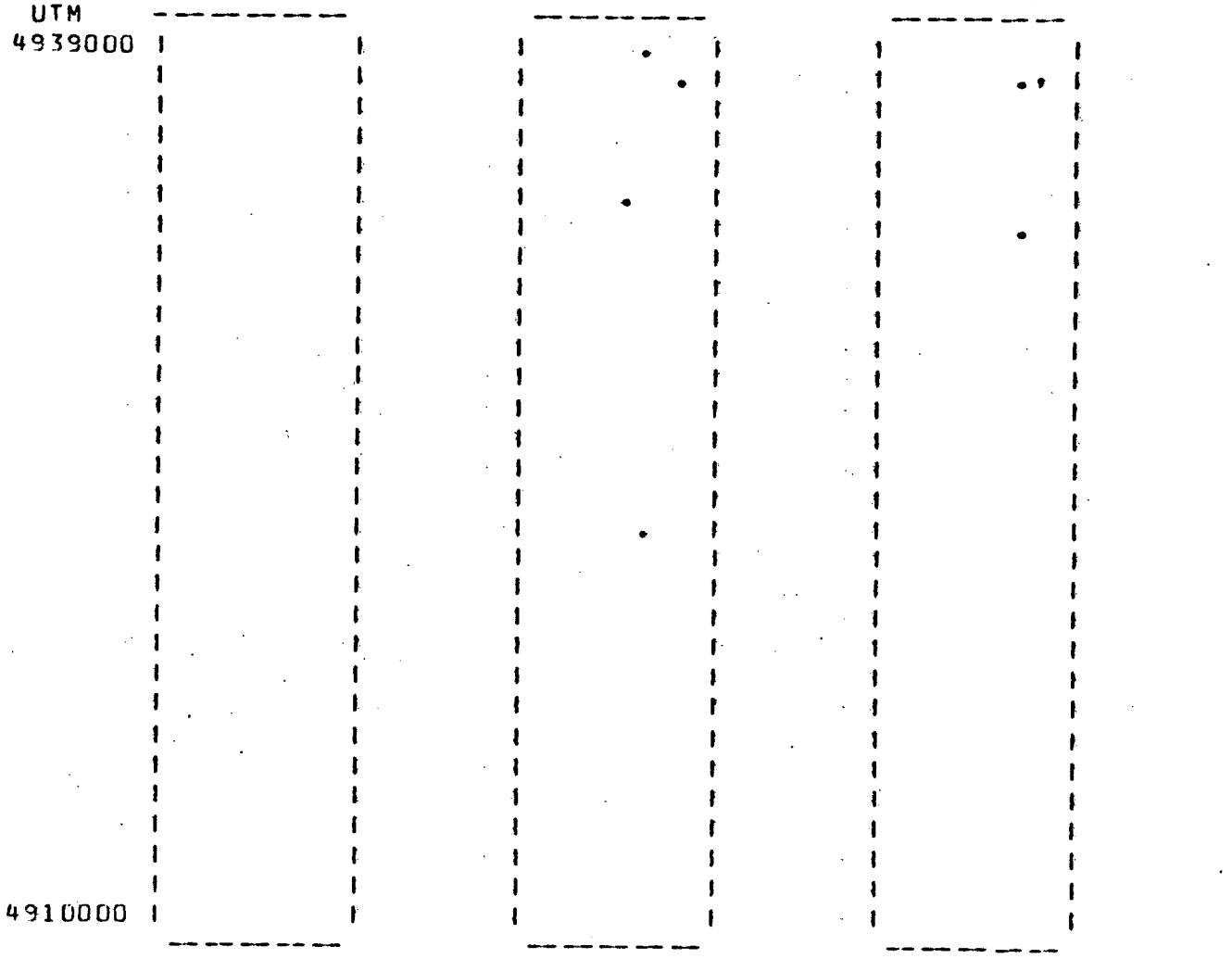
GREEN BAY TEST SITE
VARIABLE 20 LAKES, LESS THAN 50 ACRES

FIGURE 5



		A ERTS			B R857			C REMAP I			
TOT. ACRES		.00			86.45			91.39			
LEVELS		1	2	3	4	5	6	7	8	9	10
SYMBOLS		.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	&&&&&	@@@@@
RANGE (%)		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
OCCUR	A	0	0	0	0	0	0	0	0	0	0
	B	4	0	0	0	0	0	0	0	0	0
	C	2	1	0	0	0	0	0	0	0	0
ACRES	A	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	B	86.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	C	42.	49.	0.	0.	0.	0.	0.	0.	0.	0.

ERTS-1 INVESTIGATION: CONTRACT # NAS 5-21754 FIGURE 6
ENVIRON. MONITORING AND ACQUISITION GROUP
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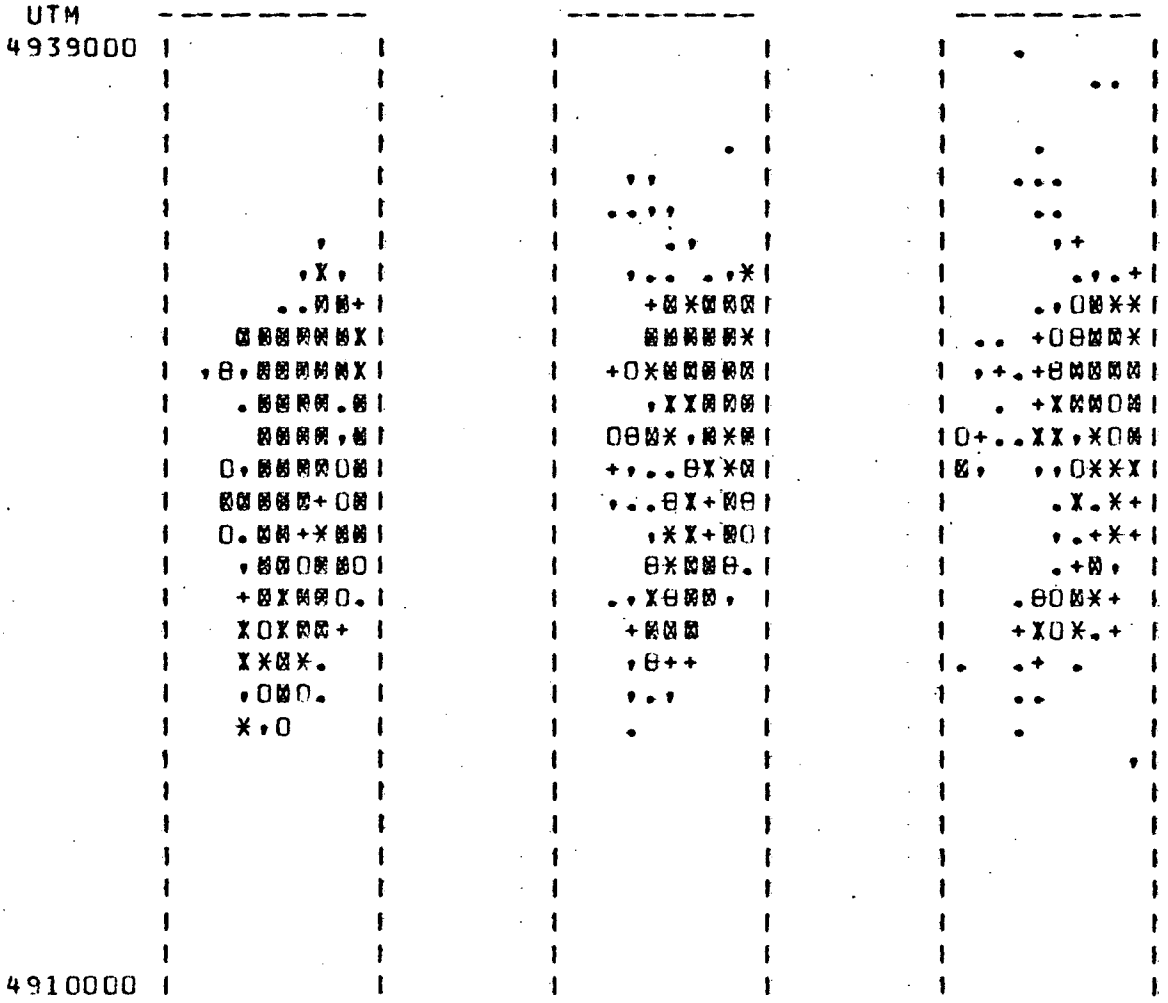
GREEN BAY TEST SITE
VARIABLE 57 + 146 RESIDENTIAL, URBAN+SUBURBAN



	A ERTS	B R857	C REMAP I
TOT. ACRES	15259.66	11907.87	9030.32

LEVELS		1	2	3	4	5	6	7	8	9	10
SYMBOLS		.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	@@@@@	&&&&&
RANGE (%)		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
OCCUR	A	8	10	5	11	1	4	7	6	8	35
	B	15	17	8	3	8	9	6	10	4	16
	C	30	11	15	8	3	10	6	6	5	3
ACRES	A	168.	457.	370.	1074.	111.	556.	1173.	1136.	1704.	8509.
	B	311.	729.	576.	309.	973.	1297.	1003.	1927.	877.	3908.
	C	672.	541.	1070.	803.	373.	1475.	1030.	1208.	1129.	731.

ERTS-1 INVESTIGATION: CONTRACT # NAS 5-21754 FIGURE 7
ENVIRON. MONITORING AND ACQUISITION GROUP
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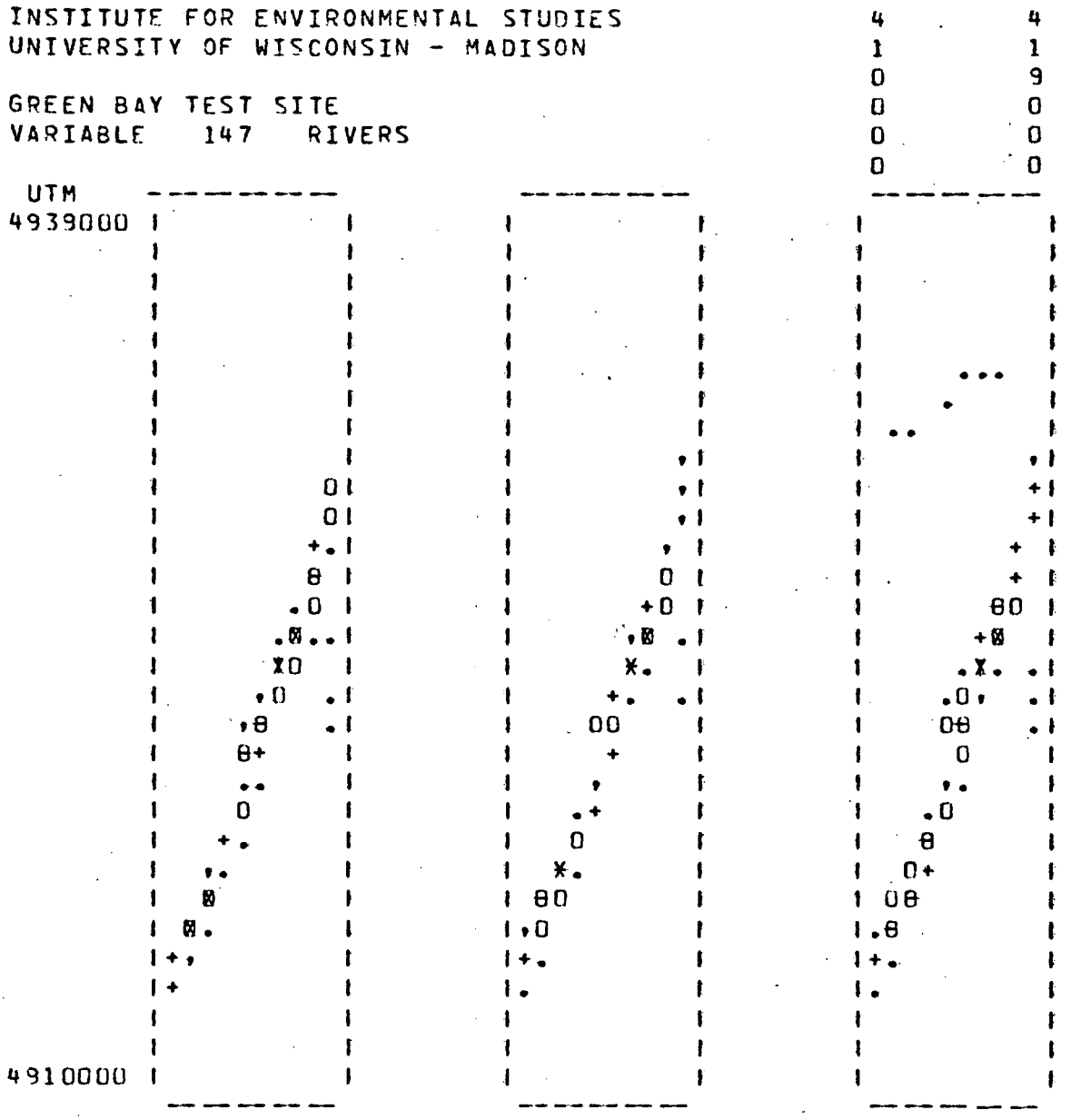
GREEN BAY TEST SITE
VARIABLE 147 RIVERS



		A ERTS	B RB57	C REMAP I
TOT. ACRES		2504.58	2116.79	2630.55
LEVELS		1 2 3 4 5 6 7 8 9 10		
SYMBOLS		. , + 0 8 * X W M #		
RANGE (%)		1-9 10-19 20-29 30-39 40-49 50-59 60-69 70-79 80-89 90-99		
OCCUR	A	12 4 5 6 3 0 1 3 0 0		
	B	8 7 5 7 1 2 0 1 0 0		
	C	17 3 7 7 5 0 1 1 0 0		
ACRES	A	299. 205. 319. 590. 336. 0. 178. 578. 0. 0.		
	B	170. 346. 370. 642. 119. 284. 0. 185. 0. 0.		
	C	329. 151. 489. 706. 600. 0. 168. 188. 0. 0.		

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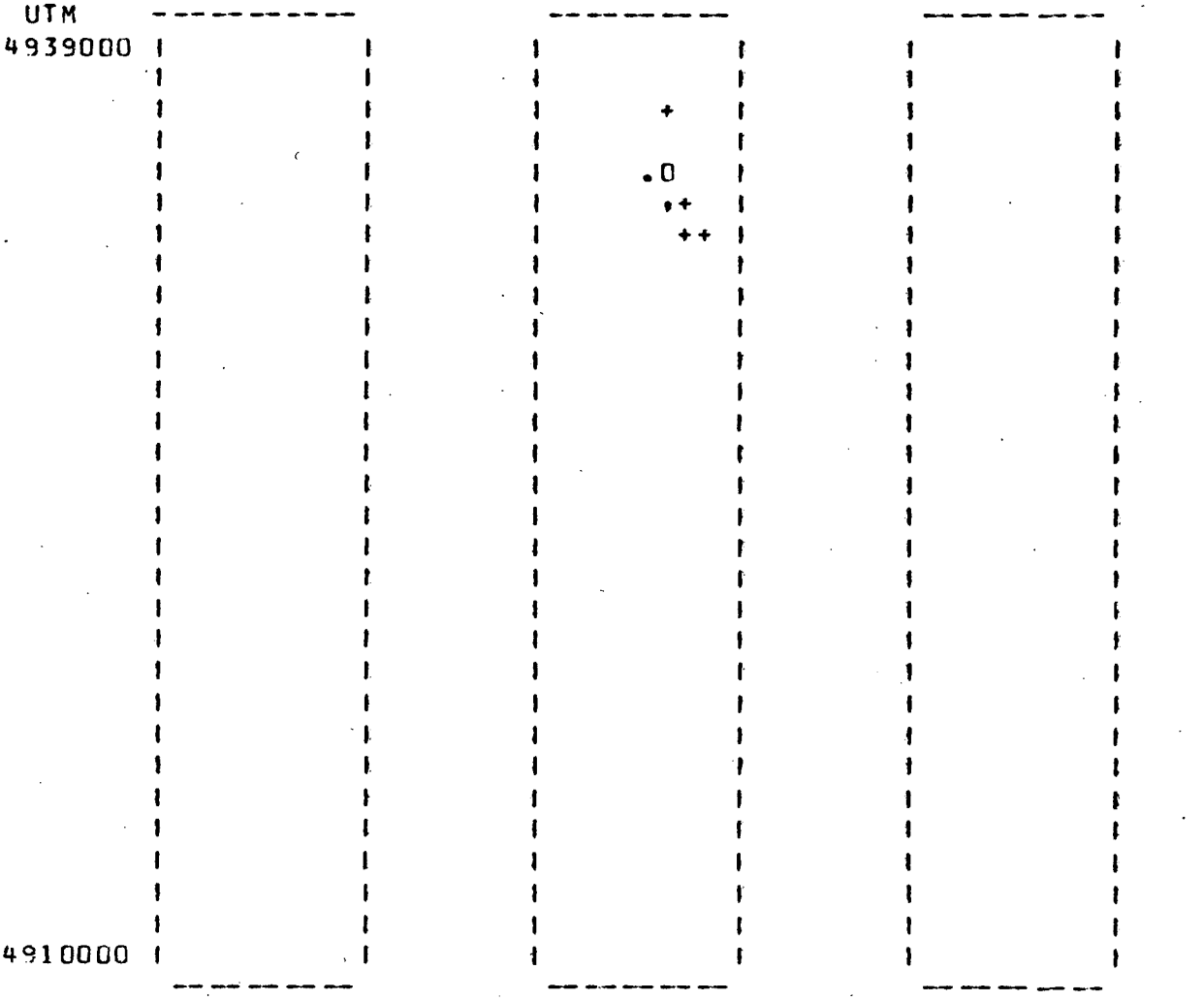
GREEN BAY TEST SITE
VARIABLE 21 LAKES

FIGURE 8



	A ERTS	B R857	C REMAP I
TOT. ACRES	.00	439.66	.00

LEVELS	1	2	3	4	5	6	7	8	9	10
SYMBOLS	.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	%%%%%	%%%%%
RANGE (%)	1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
OCCUR A	0	0	0	0	0	0	0	0	0	0
OCCUR B	1	1	4	1	0	0	0	0	0	0
OCCUR C	0	0	0	0	0	0	0	0	0	0
ACRES A	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ACRES B	20.	44.	289.	86.	0.	0.	0.	0.	0.	0.
ACRES C	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

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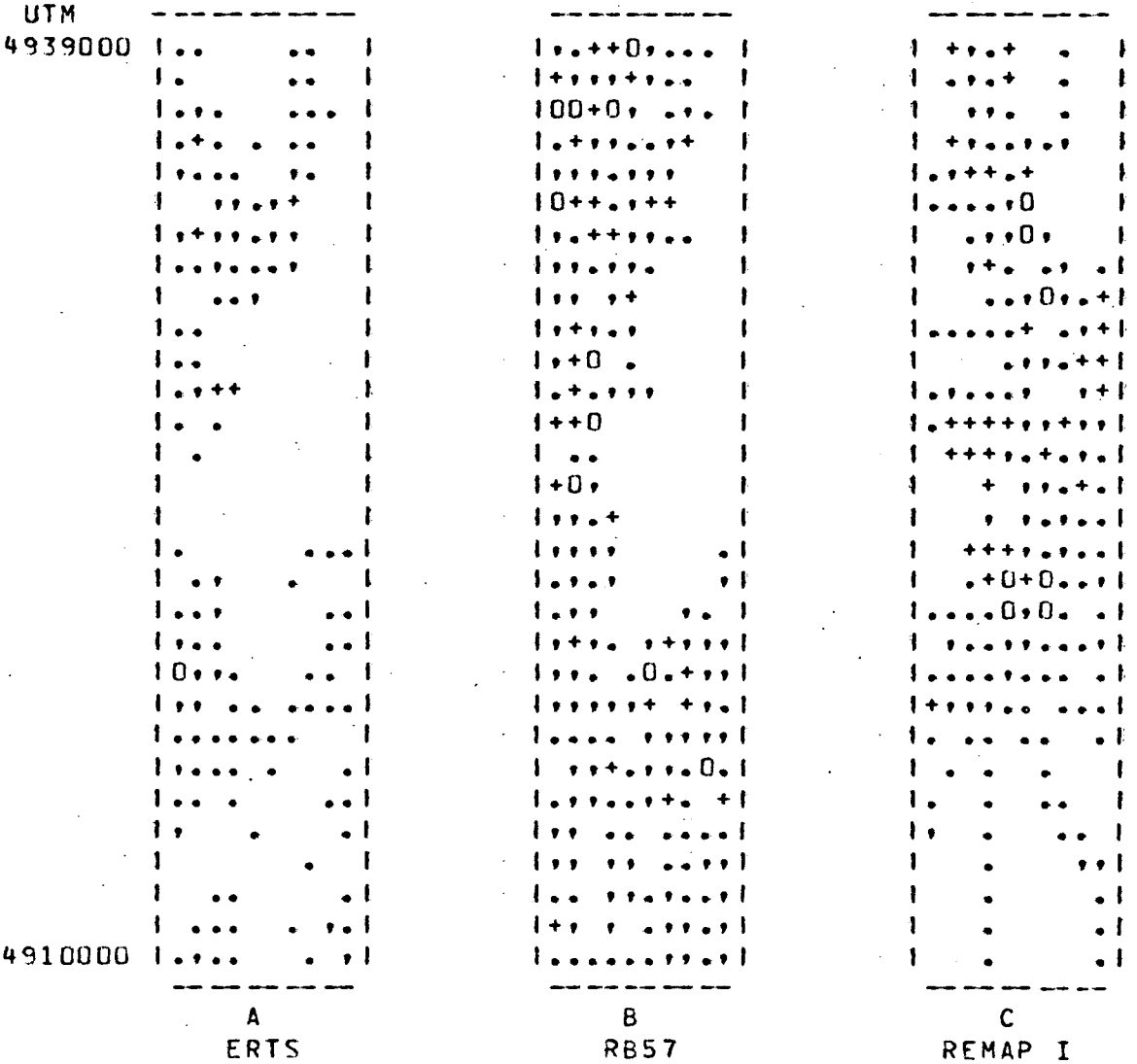
FIGURE 9

GREEN BAY TEST SITE
VARIABLE 160 ROADS



LEVELS		1	2	3	4	5	6	7	8	9	10
SYMBOLS		.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	@@@@@	######
		.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	@@@@@	######
		.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	@@@@@	######
OCCUR	A	93	27	5	1	0	0	0	0	0	0
	B	68	96	30	10	0	0	0	0	0	0
	C	97	48	31	7	0	0	0	0	0	0

ERTS-1 INVESTIGATION: CONTRACT # NAS 5-21754 FIGURE 10
ENVIRON. MONITORING AND ACQUISITION GROUP
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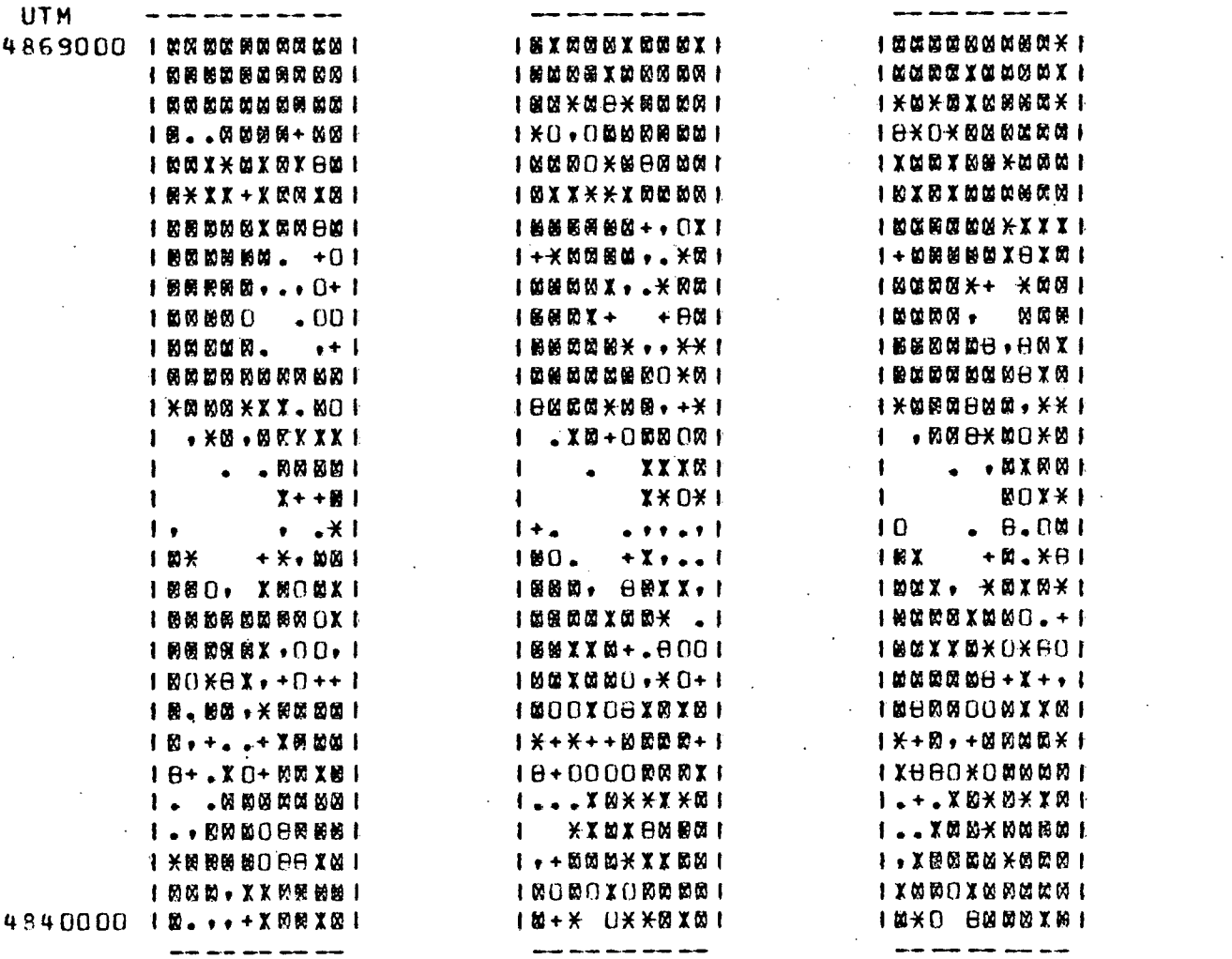
SHEBOYGAN TEST SITE
VARIABLE 63 AGRICULTURE



		A ERTS	B R857	C REMAP I
TOT. ACRES		45351.64	44830.47	48893.61
LEVELS		1 2 3 4 5 6 7 8 9 10		
SYMBOLS		..... ,,,,, +++++ 00000 88888 ***** XXXXX MMMMM &&&&& @@@@@@		
RANGE (%)		1-9 10-19 20-29 30-39 40-49 50-59 60-69 70-79 80-89 90-99		
OCCUR	A	18 18 16 16 7 11 27 51 61 48		
	B	15 15 17 24 9 29 34 36 67 30		
	C	9 9 9 14 15 29 33 52 87 20		
ACRES	A	338. 803. 1111. 1549. 840. 1581. 4532. 9843.13326.11429.		
	B	346. 709. 1262. 2337. 1089. 4229. 5790. 7059.14825. 7185.		
	C	215. 445. 672. 1383. 1823. 4347. 5676.10268.19328. 4737.		

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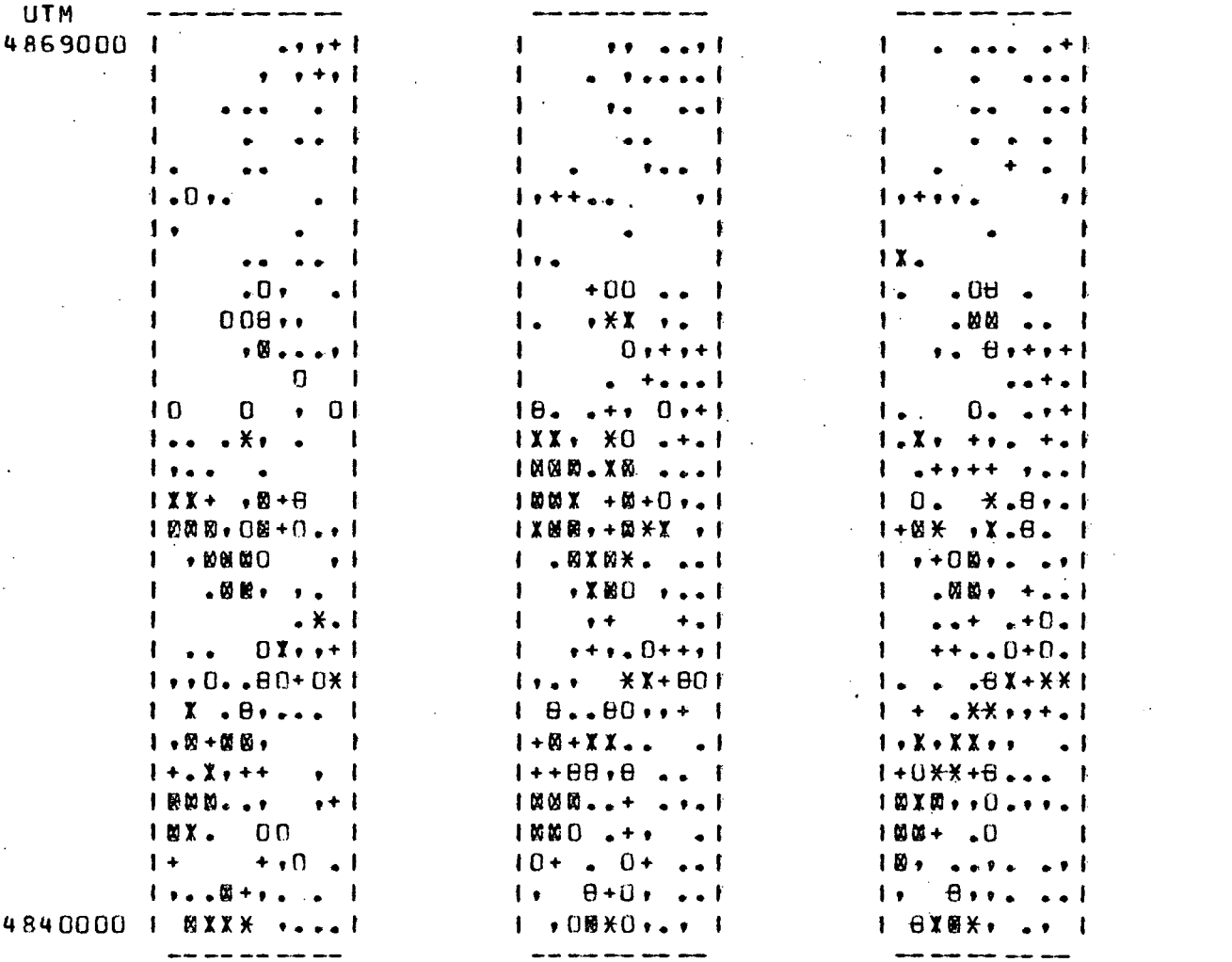
FIGURE 11

SHEBOYGAN TEST SITE
VARIABLE 24 + 25 FOREST



		A ERTS	B RB57	C REMAP I
TOT. ACRES		11991.85	14508.77	12599.46

LEVELS		1	2	3	4	5	6	7	8	9	10
SYMBOLS		.....	,,,,,	+++++	00000	00000	*****	XXXXX	%%%%%	%%%%%	%%%%%
RANGE (%)		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
OCCUR	A	56	37	15	18	4	4	8	9	7	4
	B	64	37	28	16	8	6	12	7	9	4
	C	77	36	26	10	8	9	9	5	6	1
ACRES	A	1141.	1598.	1042.	1680.	445.	568.	1329.	1736.	1514.	939.
	B	1272.	1645.	1974.	1494.	934.	877.	2018.	1358.	1974.	963.
	C	1776.	1743.	1796.	973.	988.	1284.	1492.	990.	1307.	245.

ERTS-1 INVESTIGATION: CONTRACT # NAS 5-21754 FIGURE 12

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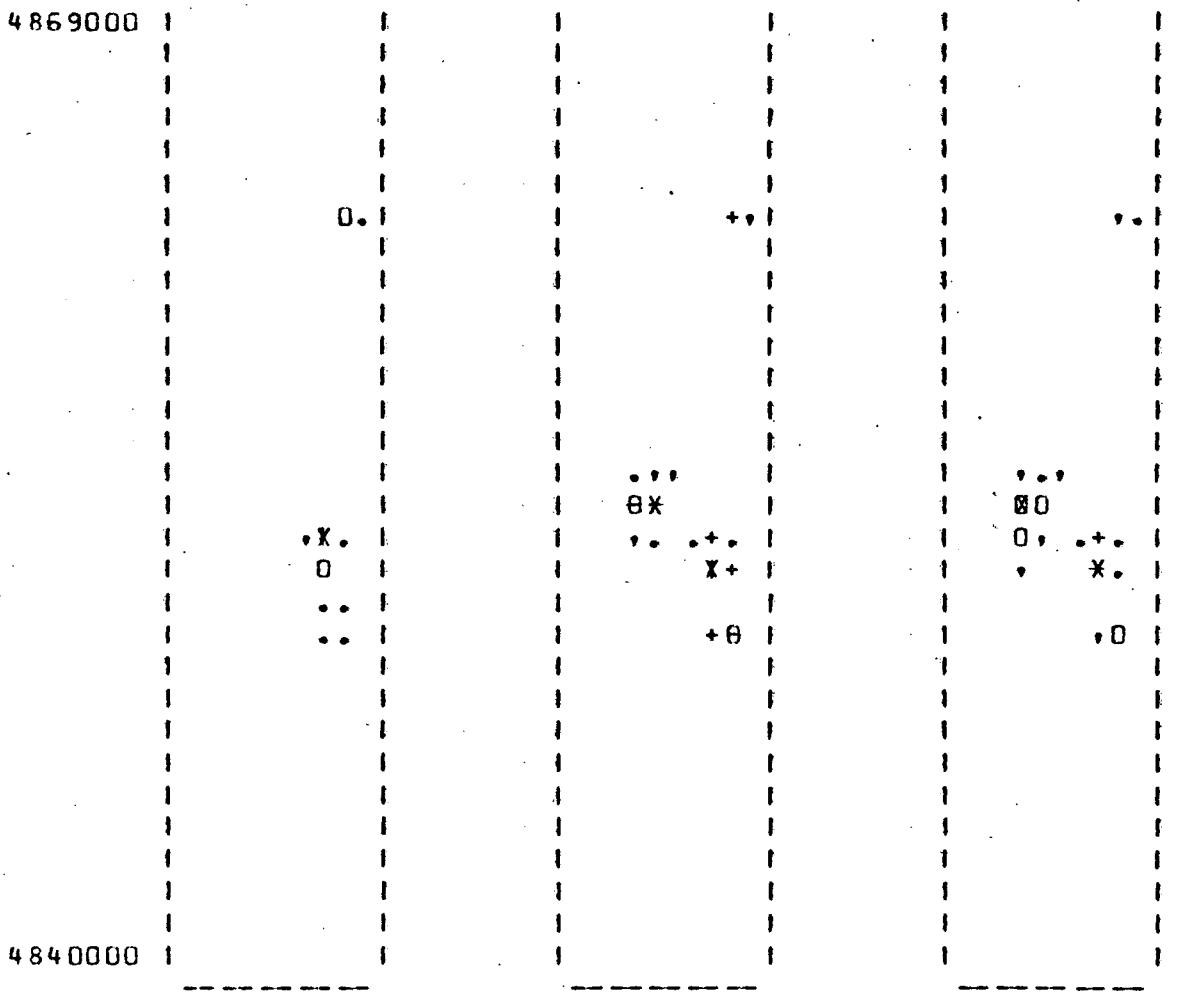
SHEBOYGAN TEST SITE
VARIABLE 21 LAKES



		A ERTS			B R857			C REMAP I			
TOT. ACRES		521.17			1064.57			1096.68			
LEVELS		1	2	3	4	5	6	7	8	9	10
SYMBOLS		.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	%%%%%	%%%%%
		.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	%%%%%	%%%%%
		.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	%%%%%	%%%%%
RANGE (%)		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
OCCUR	A	6	1	0	2	0	0	1	0	0	0
	B	4	4	4	0	2	1	1	0	0	0
	C	5	6	1	3	0	1	0	1	0	0
ACRES	A	106.	49.	0.	193.	0.	0.	173.	0.	0.	0.
	B	77.	163.	282.	0.	222.	148.	173.	0.	0.	0.
	C	104.	269.	82.	299.	0.	153.	0.	190.	0.	0.

ERTS-1 INVESTIGATION: CONTRACT # NAS 5-21754 FIGURE 13

ENVIRON. MONITORING AND ACQUISITION GROUP
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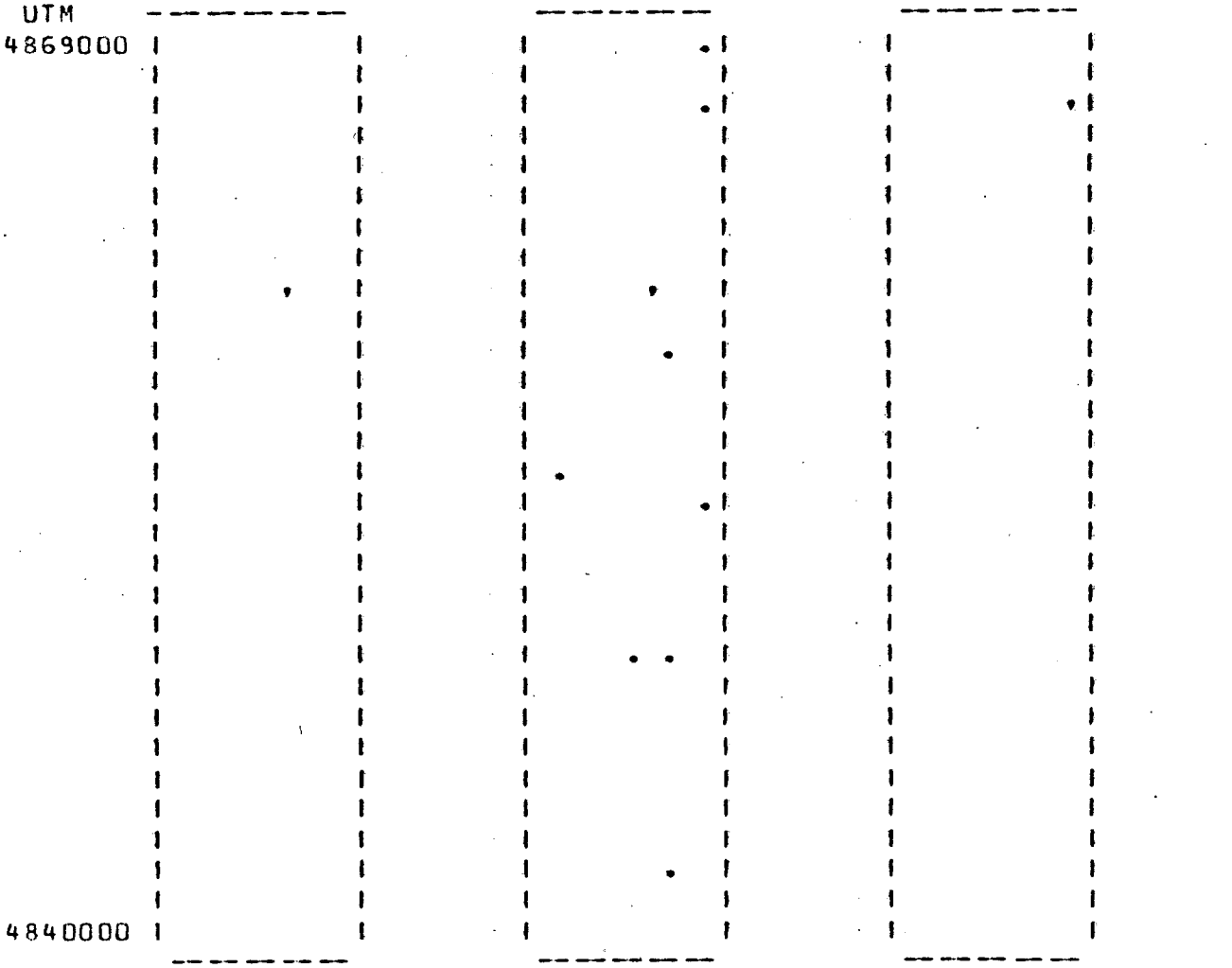
UNIVERSITY OF WISCONSIN - MADISON

SHEBOYGAN TEST SITE
VARIABLE 20 LAKES, LESS THAN 50 ACRES



	A ERTS	B RB57	C REMAP I
TOT. ACRES	37.05	160.55	39.52

LEVELS	1	2	3	4	5	6	7	8	9	10
SYMBOLS	.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	&&&&&	@@@@@
RANGE (%)	1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
OCCUR A	0	1	0	0	0	0	0	0	0	0
OCCUR B	8	1	0	0	0	0	0	0	0	0
OCCUR C	0	1	0	0	0	0	0	0	0	0
ACRES A	0.	37.	0.	0.	0.	0.	0.	0.	0.	0.
ACRES B	111.	49.	0.	0.	0.	0.	0.	0.	0.	0.
ACRES C	0.	40.	0.	0.	0.	0.	0.	0.	0.	0.

ERTS-1 INVESTIGATION: CONTRACT # NAS 5-21754 FIGURE 14
ENVIRON. MONITORING AND ACQUISITION GROUP
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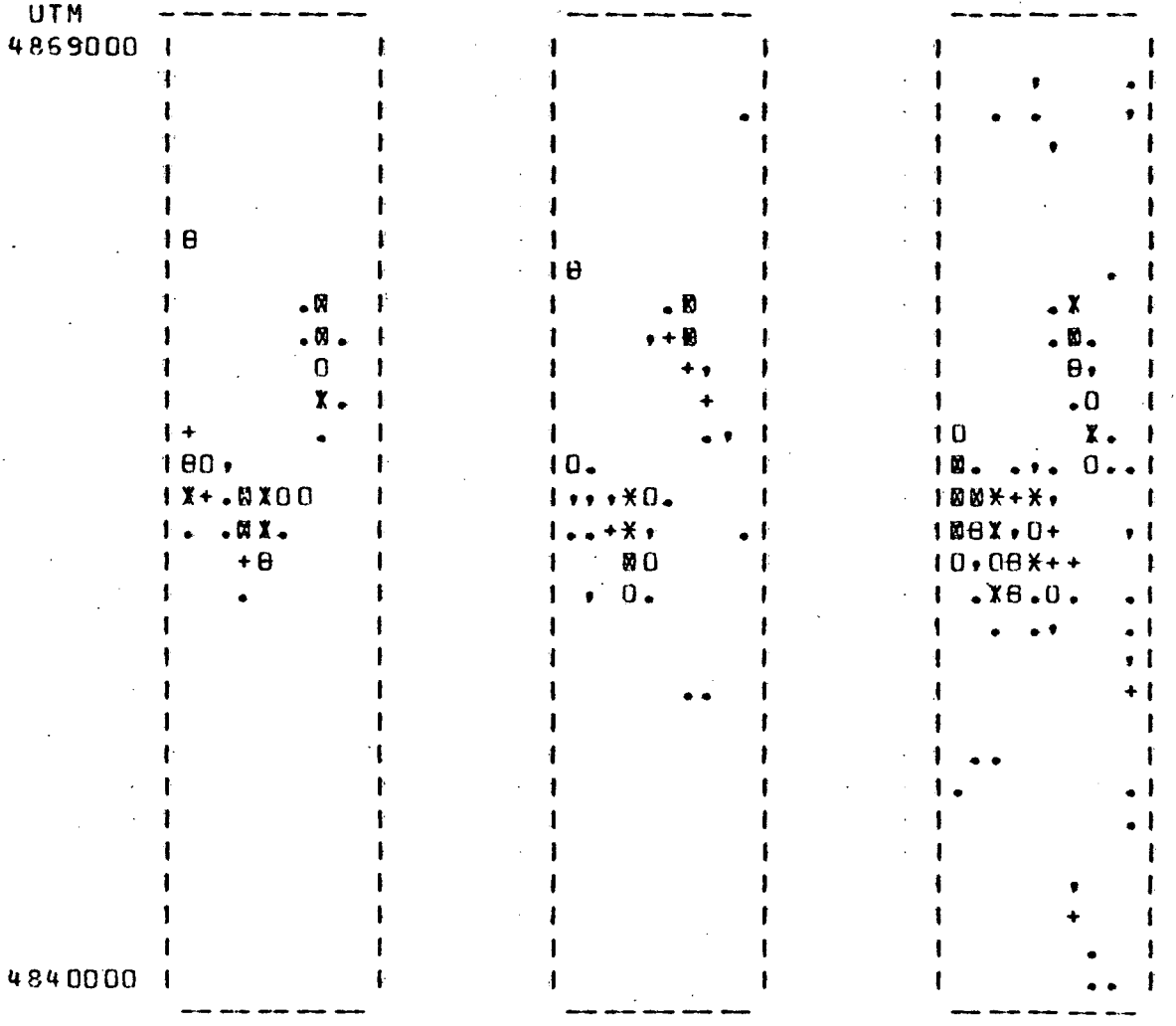
SHEBOYGAN TEST SITE
VARIABLE 26 OPEN SWAMP



		A ERTS	B RBS7	C REMAP I
TOT. ACRES		2672.54	2247.70	5001.75

LEVELS		1	2	3	4	5	6	7	8	9	10
SYMBOLS		.....	,,,,,	+++++	00000	88888	*****	XXXXX	#####	#####	######
		.....	,,,,,	+++++	00000	88888	*****	XXXXX	#####	#####	######
		.....	,,,,,	+++++	00000	88888	*****	XXXXX	#####	#####	######
RANGE (%)		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
OCCUR	A	10	1	3	4	3	0	4	3	1	0
	B	11	8	4	4	1	2	0	2	0	1
	C	29	12	6	7	4	3	4	2	3	0
ACRES	A	222.	37.	222.	346.	351.	0.	679.	598.	217.	0.
	B	225.	358.	296.	346.	111.	296.	0.	370.	0.	245.
	C	689.	558.	435.	672.	494.	430.	674.	390.	659.	0.

ERTS-1 INVESTIGATION: CONTRACT # NAS 5-21754 FIGURE 15
ENVIRON. MONITORING AND ACQUISITION GROUP
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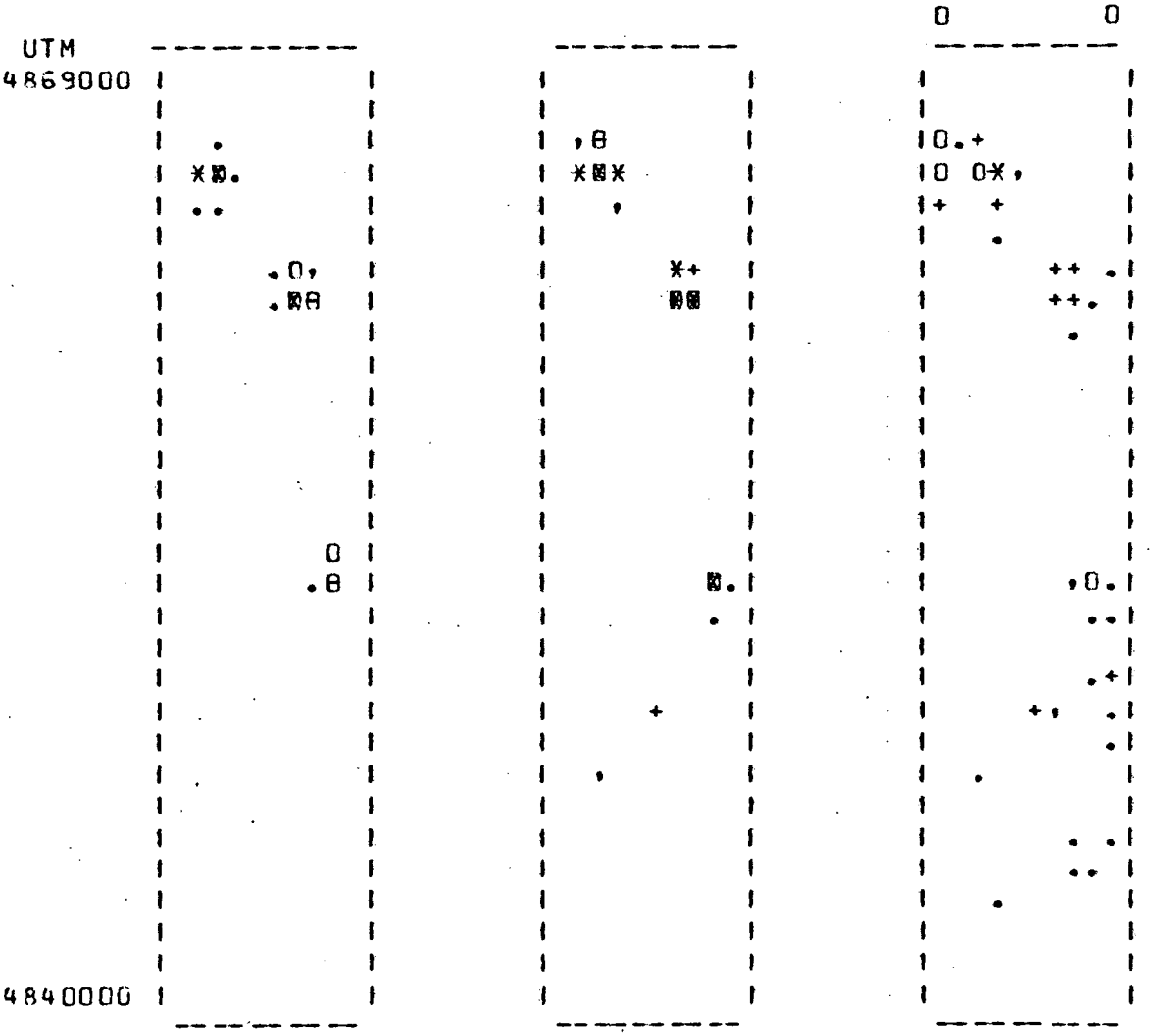
UNIVERSITY OF WISCONSIN - MADISON

SHEBOYGAN TEST SITE
VARIABLE 57 + 146 RESIDENTIAL, URBAN+SUBURBAN



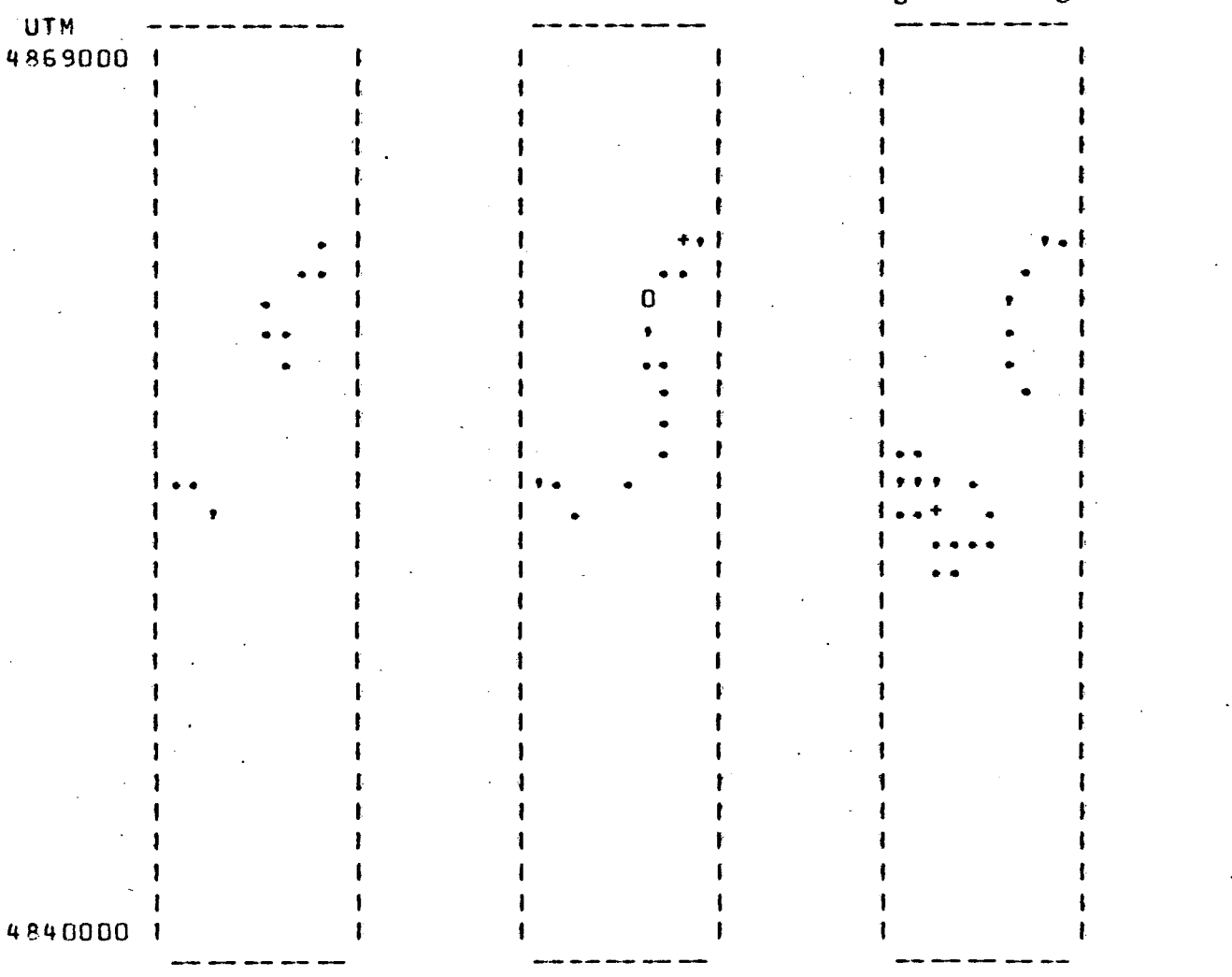
		A ERTS	B RB57	C REMAP I
TOT. ACRES		1160.90	1842.62	1714.18

LEVELS		1	2	3	4	5	6	7	8	9	10
SYMBOLS		.....	,,,,,	+++++	00000	88888	*****	XXXXX	MMMMM	WWWWW	@@@@@
		.....	,,,,,	+++++	00000	88888	*****	XXXXX	MMMMM	WWWWW	@@@@@
		.....	,,,,,	+++++	00000	88888	*****	XXXXX	MMMMM	WWWWW	@@@@@
RANGE (%)		1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
OCCUR	A	7	1	0	2	2	1	0	0	2	0
	B	2	3	2	0	1	3	0	0	1	3
	C	17	3	9	4	0	1	0	0	0	0
ACRES	A	86.	49.	0.	198.	247.	148.	0.	0.	432.	0.
	B	44.	138.	148.	0.	114.	442.	0.	0.	222.	734.
	C	388.	143.	647.	395.	0.	141.	0.	0.	0.	0.

ERTS-1 INVESTIGATION: CONTRACT # NAS 5-21754
ENVIRON. MONITORING AND ACQUISITION GROUP
INSTITUTE FOR ENVIRONMENTAL STUDIES
UNIVERSITY OF WISCONSIN - MADISON

FIGURE 16

SHEBOYGAN TEST SITE
VARIABLE 147 RIVERS



		A ERTS	B RB57	C REMAP I
TOT. ACRES		227.24	511.29	649.61

LEVELS	1	2	3	4	5	6	7	8	9	10
SYMBOLS	.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	%%%%%	%%%%%
	.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	%%%%%	%%%%%
	.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	%%%%%	%%%%%
RANGE (%)	1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
OCCUR A	9	1	0	0	0	0	0	0	0	0
OCCUR B	10	3	1	1	0	0	0	0	0	0
OCCUR C	17	5	1	0	0	0	0	0	0	0
ACRES A	188.	40.	0.	0.	0.	0.	0.	0.	0.	0.
ACRES B	227.	123.	62.	99.	0.	0.	0.	0.	0.	0.
ACRES C	375.	212.	62.	0.	0.	0.	0.	0.	0.	0.

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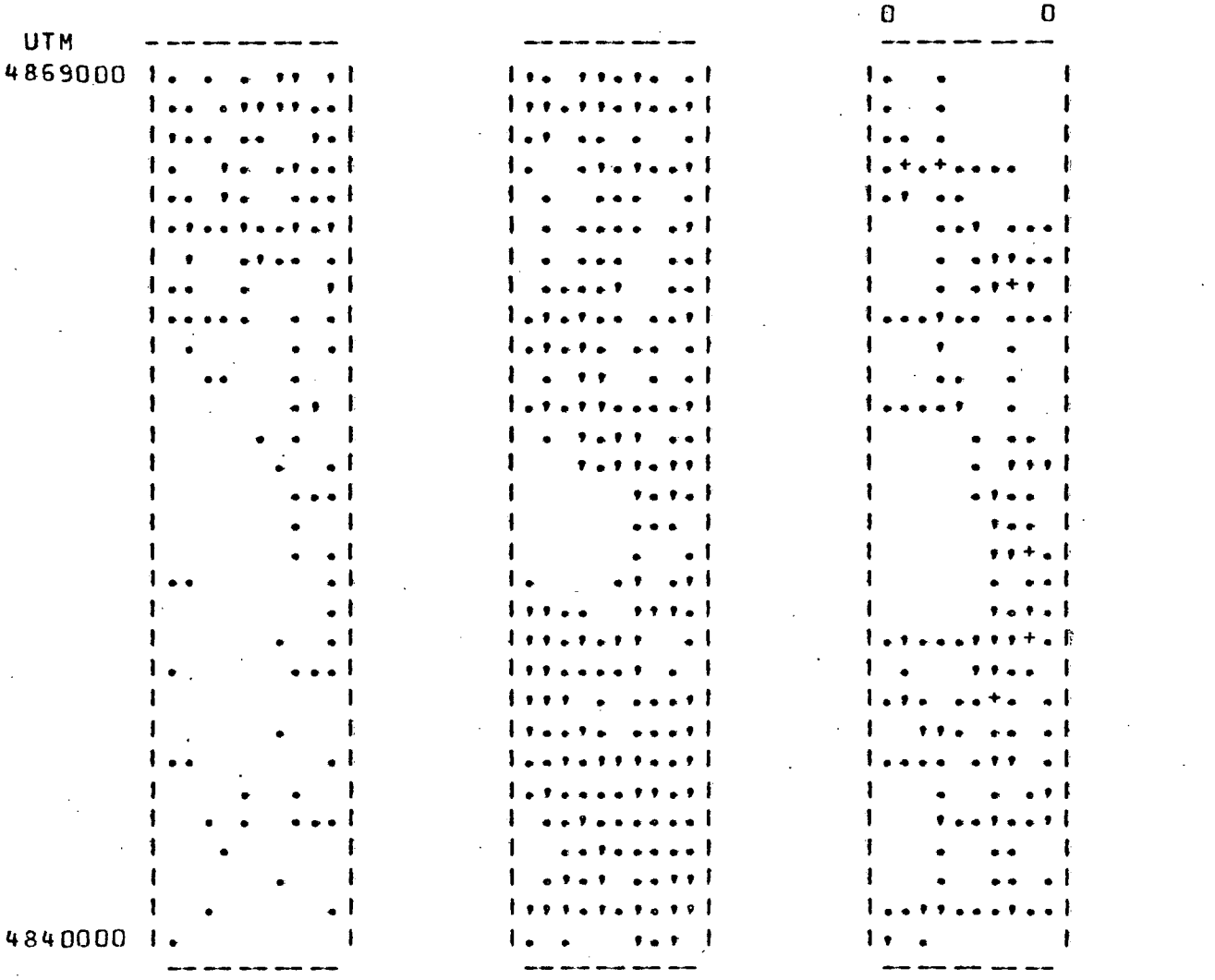
FIGURE 17

SHEBOYGAN TEST SITE
VARIABLE 160 ROADS



LEVELS		1	2	3	4	5	6	7	8	9	10
SYMBOLS		.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	%%%%%	%%%%%
		.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	%%%%%	%%%%%
		.....	,,,,,	+++++	00000	88888	*****	XXXXX	%%%%%	%%%%%	%%%%%
OCCUR	A	87	20	0	0	0	0	0	0	0	0
	B	135	83	0	0	0	0	0	0	0	0
	C	105	37	6	0	0	0	0	0	0	0

REMAP-I [C]); and 10) acres per level for each of the three interpretations.

Examining the total acres representations of the spatial correlations Figures 1-8 and 10-16 illustrate preliminary but revealing significance of ERTS-1 derived data. (Figures 9 and 17 are of the variable roads for which acre comparisons were not made.)

Total acres as derived:	ERTS	RB-57	REMAP-I
Green Bay test site:			
agriculture	24,391	39,846	39,371
escarpment	2,470	2,223	2,223
forest	7,637	5,994	8,543
Lake Michigan	3,356	2,346	2,099
lakes less than 50 acres	undetectable	86.45	91.39
resid., urban, suburban	15,259	11,907	9,030
rivers	2,504	2,116	2,630
lakes	undetectable	439	undetectable
Sheboygan test site:			
agriculture	45,351	44,830	48,893
forest	11,991	14,508	12,599
lakes	521	1,064	1,096
lakes less than 50 acres	37	160	39
open swamp	2,672	2,247	5,001
resid., urban, suburban	1,160	1,842	1,714
rivers	227	511	649

Examining the above total acres figures suggests, for the region studied, that generally correlations between the three means of deriving information are good. Assuming, however, that the RB-57 derived data represents "ground truth" (which is a reasonable assumption at the present time, although we intend to investigate these correlations during late spring and summer), certain conclusions can be made about ERTS-1 as an information source from this preliminary study (recognizing that this is for a specific area and that data was interpreted through manual inspection with a grid overlay and converted into percentile occurrence

classes per one kilometer area).

1. In general the ERTS-1 interpretation resulted in a higher total number of acres than the other sources. This suggests that interpreters must recognize the resolution capabilities of ERTS and develop skill in under-predicting percentage occurrence of given variables.

2. In general, there existed a closer correlation between the RB-57 derived data and the stored conventional data of REMAP-I than with ERTS-1 derived data. It is important to recognize that in comparing with existing data sources the best utility of ERTS may not be realized. The fact that these types of data have been mapped previously may suggest that the best utility of ERTS-1 data is in determining measurements of data not traditionally mapped. It is these variables, usually unmapped, that are missing in the present regional planning and decision making process. As an example, in the "Sheboygan test site" the variable "open swamp" represents the type of data not traditionally mapped (and usually is from archaic sources). Examining Figure 14 it can be seen that there is a very good correlation between the ERTS-1 derived data and the RB-57 (i.e. ERTS, 2672 acres of "open swamp"; RB-57, 2247 acres; and REMAP-I, 5001 acres). Another data type also not mapped often that shows correlation to the RB-57 is forests. The indication of the use of ERTS towards identifying features not presently mapped is significant.

3. In examining the correlations between the three data sources at various levels or percentages of occurrence, it can be observed that correlations are often quite good with ERTS and RB-57 data in relation to occurrences of given data at greater than 50% predominance in the one kilometer cell. This suggests that the ERTS data is often more accurate than the conventional data if the given features are able to be sensed by the resolution capabilities of ERTS.

Of the previous three points, the importance of ERTS to

regional planning concerns in relation to types of data not available from conventional sources is perhaps the most critical. The variable "open swamp" in reference to Figure 14 deserves to be explained in more detail.

The information derived from ERTS imagery was interpreted from two different dates examined concurrently - 14 September and 13 December 1972. In examining the four MSS bands, the images produced by Band 5 were found to present the most information for this particular variable for the dates data were available.

Information from the RB-57 photographs was interpreted from color infrared positive transparencies taken in September 1971 (September has been found to be a superior time for photo interpretation of many vegetational communities in this region).

"Open swamp" as it exists in the REMAP-I data bank was obtained from two sources: (1) Borgner land cover survey maps, and (2) interpretation of small-scale panchromatic aerial photographs. The Borgner studies represent the most complete inventory of vegetational resources for the entire state of Wisconsin. They were ground studies done during the 1930's in which species types and communities identification were made. While some areas of the state have been studied more recently (e.g., Menominee County), no other data source exists for the state as a whole. The Borgner studies were supplemented with interpretations from black and white aerial photographs in an attempt to update the Borgner maps.

Figure 14 illustrates certain differences in the spatial distribution of the variable "open swamp" as derived from the three data sources. From preliminary investigations (ground studies and re-check of interpretations), it is our conclusion that the ERTS and RB-57 derived data are a closer approximation of the location and extent of the wetland resource in the test site than the data now stored

in the REMAP-I data bank. The REMAP-I data represent the best existing data as derived from conventional data sources. These REMAP-I data are less valid than ERTS and RB-57 data for two reasons: (1) many areas that were wetland communities in the 1930's when the Borgner maps were compiled have disappeared, and (2) the data sources used were conducive to generating errors. These errors exist in both the original Borgner studies (now generally recognized by Wisconsin ecologists as being of limited value) and in extraction and classification errors when using small-scale panchromatic photographs as a data source for interpretation. Many lowland forest areas were incorrectly coded as wetlands and account for the larger total number of "wetlands" stored in the REMAP-I data bank. Such classification errors were not made during interpretation from ERTS-1 or RB-57 data because: (1) the data were of recent vintage (1971-1972), and (2) the interpreters were able to differentiate well between lowland forest and open swamp. In the case of interpretations from RB-57 color infrared photographs (September 1971),community distinctions were possible because many plants were entering dormancy. In the case of interpretations from ERTS images, these distinctions were possible by means of an examination of two dates of imagery (September and December).

In comparing the ERTS-derived data with the RB-57 derived data, both the spatial results and the numerical quantities are as expected. It appears that certain small wetland areas (e.g., less than 10% of a cell) can be recognized on RB-57 photographs but cannot be identified on the ERTS images due to resolution limitations. Resolution and edge definition characteristics appear to influence an interpreter into perceiving higher percentile levels (percents of cell classified as open swamp) on ERTS images than on RB-57 photographs.

It is important to note that the delineating of wetlands, their extent and degree of occurrence, is only the first step in a resource inventory. Eventually, questions of wetland diversity, wetland quality, amount of biotic habitat,

and similar concerns must be quantified. Many of these questions can be approached with RB-57 and ERTS data.

The importance of open swamps or wetlands in the state of Wisconsin is evidenced by two major study committees that were initiated in the summer of 1971: the Governor's Land Resources Committee, and the University of Wisconsin Faculty Land Use Problem Definition Seminar. Interim recommendations of these committees led to the development of the major programs within the state of Wisconsin (Department of Administration): Wisconsin Land Use Information System and Critical Resources Information Program. During 1972 these programs have been evidenced in a recent decision by the Wisconsin Supreme Court concerning wetlands at a cultural resource. The state of Wisconsin has recently embarked upon a Critical Resources Information Program aimed at the definition, inventory and monitoring of the critical natural and cultural resources which are essential to a balanced environment in Wisconsin. This program is to be coordinated with the Wisconsin Land Use Information System, a spatial geo-information program, initiated in 1972. Both programs will require the input of vast amounts of land resource data in a variety of formats.

This legislation, of course, responds to major existing and proposed Federal legislation that we are all aware of: Environmental Impact Legislation; National Coastal Zone Management Act of 1972 (signed into law by the President); the Rural Development Act of 1972 (signed into law by the President); and the Land-Use Policy and Planning Assistance Act of 1972. Each of these programs necessitated a means to continually monitor a wide array of natural and cultural data with emphasis on "critical resources."

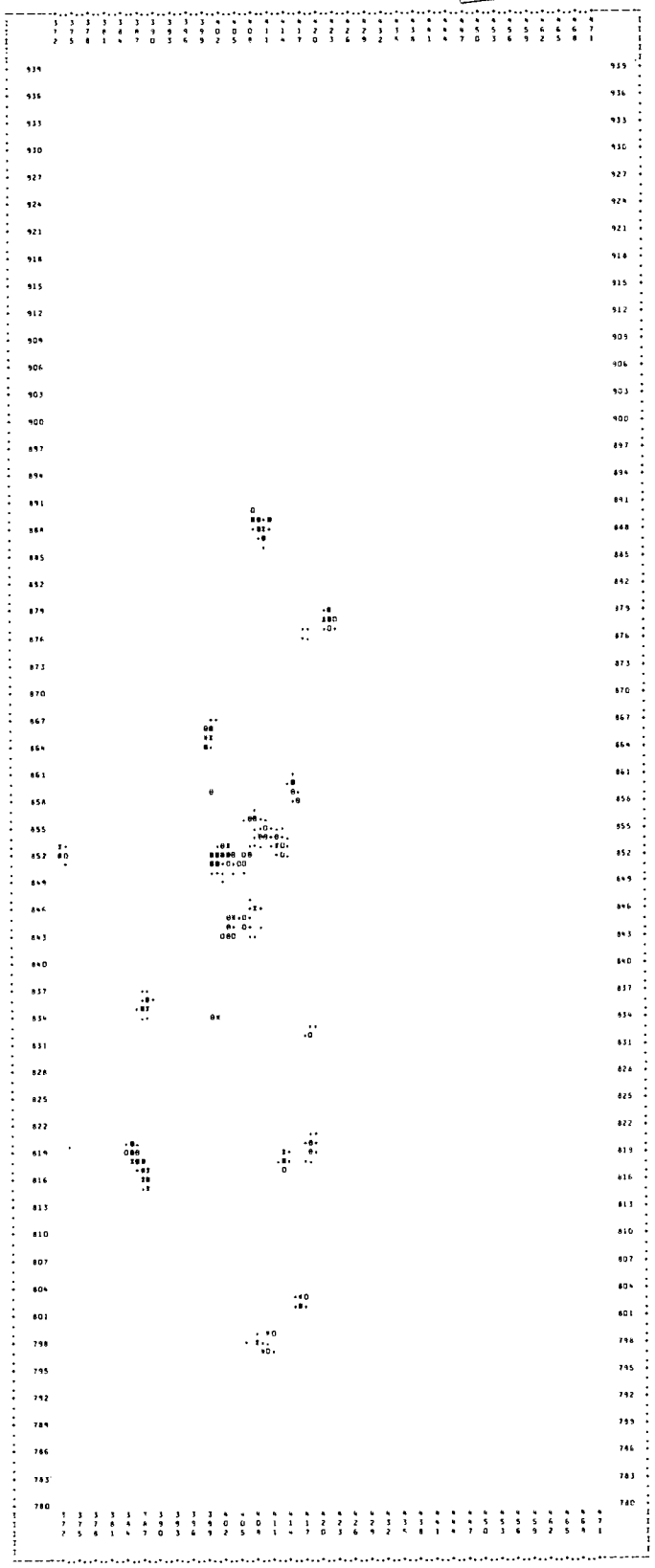
At present, uniform sources of critical resource data for large geographic areas such as the state of Wisconsin are either non-existent or of such gross resolution as to be of little value in the planning/legislative process. For example,

there does not exist a total assessment of the wetland systems in the state even though legislation is being proposed for their protection.

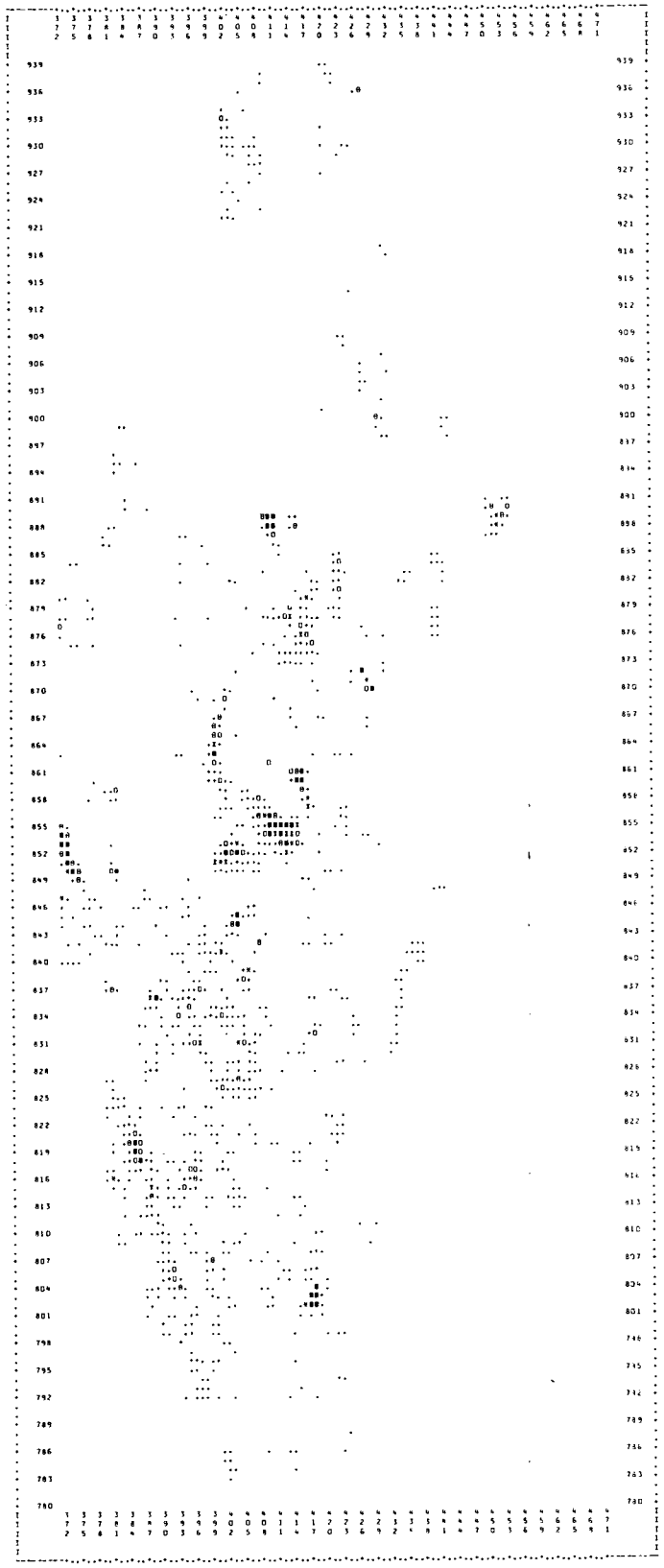
Due to these concerns, wetlands were examined over the entire 10,000 square kilometer study area of southeastern Wisconsin. Figure 18, a fold-out, illustrates the output of computer correlations with data derived from three different sources (i.e., A) ERTS, B) RB-57, and C) REMAP-I stored data. The programming format is the same as used to produce Figures 1-17. Spatial examining of the three printouts for the study area illustrates many of the same conclusions for this area of the state as identified in the Sheboygan sample study. It is apparent that in terms of a first approximation of the extent and location of open swamp the ERTS-derived information correlates quite well, especially in identifying major areas. It is also apparent that the REMAP-I data base due to archaic source data (Borgner and ASCS photos) recognize many wetlands that are now non-existent. The wetlands interpretations from ERTS imagery were done from a NASA color composite taken on 9 August 1972. We now feel that this did not provide as much information as the two dates (14 September and 13 December) used to interpret "open swamp" for the Sheboygan sample. It is planned that during the following period we will interpret ERTS imagery from one winter and one spring date to again spatially correlate over the entire data base with the data derived from other sources. Additionally, we intend to correlate with other types of data that is not well mapped but exists in certain of our other data bases such as extent and location of coniferous and deciduous forests. In an attempt to get at the various real costs between the different data sources, we analyzed the differences in producing the three computer stored spatial data bases. We assume that if we were a regional planning agency we would have access to ASCS files or Sioux Falls distribution center.

EOTS-1 INVESTIGATION: CONTRACT # NAS 5-21754
ENVIRONMENTAL MONITORING AND DATA ACQUISITION GROUP
INSTITUTE FOR ENVIRONMENTAL STUDIES
UNIVERSITY OF WISCONSIN - MADISON

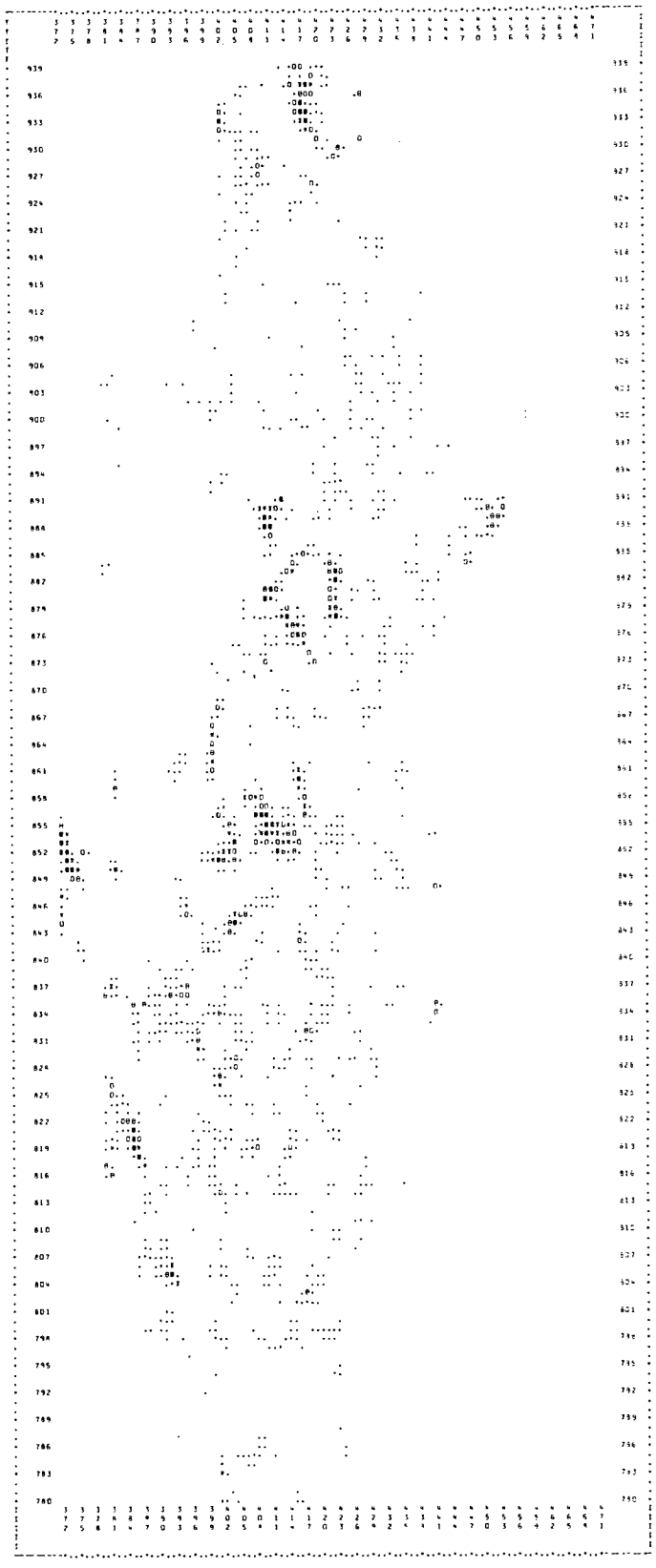
SOUTHEAST WISCONSIN TEST SITE
VARIABLE 26 OPEN SWAMP



A
EOTS
TOTAL ACRES - 18697.90



B
RASA
TOTAL ACRES - 34191.80



C
OPENED
TOTAL ACRES - 69703.40

LEVELS	1	2	3	4	5	6	7	8	9	10
SYMBOLS	.....	.....	.....	00000	88888	*****	#####	#####	#####	#####
RANGE (%)	1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
OCCURANCE A	346.	2371.	2223.	2075.	2346.	889.	2421.	1334.	1778.	2370.
OCCURANCE B	14153.	12992.	5483.	4446.	3561.	2223.	2593.	1976.	1779.	2964.
OCCURANCE C	14772.	12592.	8077.	7511.	5187.	4893.	4458.	2964.	3334.	2717.
ACRES A	34	98	30	73	19	6	24	9	17	10
ACRES B	573	263	74	45	29	15	15	10	17	12
ACRES C	760	263	109	74	42	33	20	15	15	11

8. (a)

FOLDOUT FRAME 1 26

8 (b)

FOLDOUT FRAME 2

REMAP-I Derived Information:	
ASCS B&W photos (stereo coverage over 10,000 sq. km.; 1000 frames @ $1.25 ea.)	$2,000.00
Xerox of Borgner Studies	70.00
	$2,070.00
RB-57 Derived Information:	
9"x9" CIR transparencies (50 frames @ $7.00 ea.)	$ 350.00
ERTS-Derived Information:	
2 - 9"x9" color composites @ $7.00 ea.	$ 14.00

These price differences are quite revealing and certainly increase the attractiveness of the first approximation nature of the ERTS-derived data. It should be recognized that the REMAP and the RB-57 data also require an inordinate amount of time in locating reference points for transfer to the grid base.

It came to our attention that the state of Wisconsin was considering contracting aerial missions for wetland identification. Through a series of meetings we suggested that ERTS could serve as an appropriate data source for first approximation location and extent of wetlands. Specifically, we suggested to construct mosaics of Wisconsin and delineate major wetlands for the state of Wisconsin. It is our intent to do this from two different time periods, (1) 13 December and (2) spring, given state coverage. We feel these two time periods will average into a significant representation of the wetlands of the state. For this study wetlands were low, often depressed land surfaces covered with water during at least some part of the year. They include open swamp being distinguished vegetatively by gradients and mixtures of emergent aquatics (algae and macrophytes), grasses and sedges, and deciduous, coniferous shrubs; southern lowland forests as bottom land or floodplain forests and hardwood swamps on lake borders; and northern lowland forests as bog forests, conifer swamps, and hardwood swamps which exist on glacial lake beds and river floodplains.

Figure 19 is a black and white color photo of the completed Wisconsin mosaic 1:1,000,000 from the week of 13 December 1972. Figure 20 represents the preliminary wetland inventory for the entire state done from that mosaic. As noted above, we intend to complete additional mosaics from other dates and from the December image a mosaic constructed at 1:500,000. This imagery is quite informative for determining physiographic regions (due to a light snow cover and low sun angle) which is also expected to illustrate the utility of ERTS.

As reported in our previous progress report (1 February), a matrix comparing available imagery to the REMAP I and II data was developed. These matrices (Appendix 1) analyze all available dates (regardless of format) that would include coverage over the geographic region of the REMAP data bank. Some of these matrices were presented in the previous progress report; however, we have redone the structure of matrix and are submitting new matrices for 9 August to 5 February every two weeks conclusively.

The matrix records information on data type, date, cloud cover and identification code. The identification code includes the following descriptions:

Data Cannot be Identified

- Quality too poor for identification (resolution, cloud cover)
- Not available
- Data item cannot be identified

Data Can be Identified

- Data item identified with difficulty
- Data item identified
- Data item readily identified
- Image format most appropriate for identification

In conclusion, we feel we are beginning to realize the full potential of ERTS-1 data. We have finally received some color composites and are beginning to examine them. On 4 May we have scheduled another meeting of our advisory council (representatives from various land use concerns in the state

10(a)

FIGURE 19 MOSAIC OF WISCONSIN

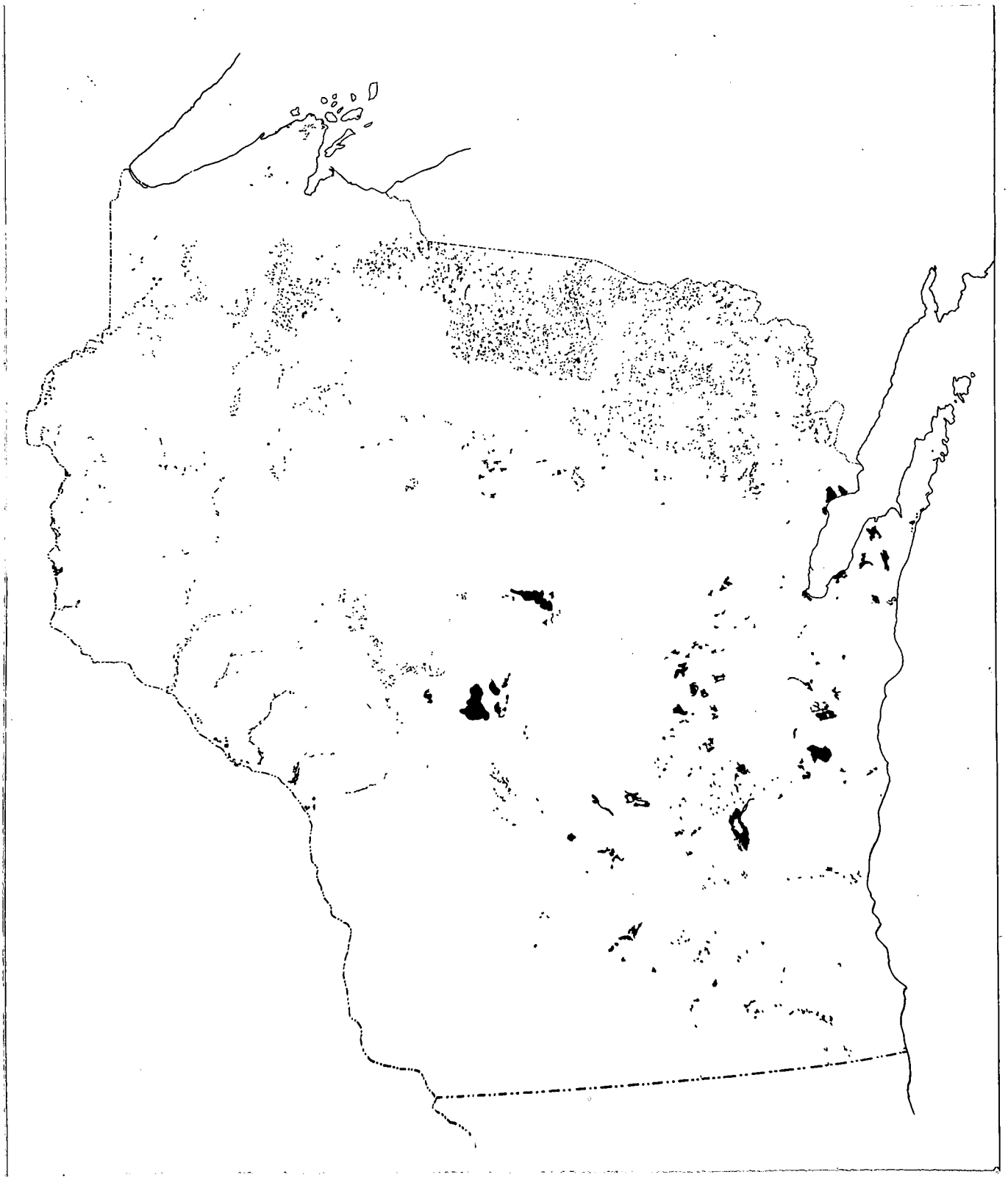


FIGURE 20 PRELIMINARY WETLANDS MAP FROM ERTS-1 IMAGERY

of Wisconsin). We foresee a number of significant results by that time and then for the June Type II Progress Report in which we will have been able to make correlations from summer 1972 imagery through spring 1973.

E. Discussion of Significant Results

None at this time. Although preliminary, we feel the results introduced in Section D are quite revealing. Continued testing during the following period should illustrate the significance of this research to the state of Wisconsin land use concern.

F. Listing of Published Papers, Articles

Clapp, J.L., R.W. Kiefer, M.M. McCarthy and B.J. Niemann, 1973. "The use of ERTS-1 data for the inventory of critical land resources for regional land use planning." In Symposium on Significant Results Obtained from ERTS-1, NASA, Goddard Space Flight Center, Greenbelt, Maryland. (Copy included as Appendix 2)

G. Recommendations

None at this time.

H. Standing Order Changes

None at this time.

I. ERTS Image Descriptor Form

See Appendix 3.

J. Data Request Forms Submitted During Reporting Period

See Appendix 4.

APPENDIX 1

Code: Data Can Be Identified

Data Item Identified with Difficulty...	1
Data Item Identified.....	2
Data Item Readily Identified.....	3
Image Format Most Appropriate for Identification	(#)

Data Cannot Be Identified

Quality Too Poor for Identification (Resolution, Cloud Cover).....	P
Not Available.....	N
Data Item Cannot be Identified.....	C

Date/% Cloud Cover	Aug. 9/ 20%					Aug. 27/ 70%					Sept. 14 10%				
	4	5	6	7	C	4	5	6	7	C	4	5	6	7	C
AGRICULTURAL	2	3	1	1	(3)	P	P	P	P	P	P	(3)	1	1	N
BEACH RIDGE	C	C	C	C	C	P	P	P	P	P	C	C	C	C	N
COMMUNICATIONS, AIRFIELDS*	1	(2)	C	C	2	P	P	P	P	P	2	(3)	C	C	N
DRUMLINS	1	2	C	C	(2)	P	P	P	P	P	P	(2)	1	1	N
END MORAINE	2	(3)	C	C	2	P	P	P	P	P	1	(2)	C	C	N
ESKER	C	C	C	C	C	P	P	P	P	P	C	C	C	C	N
ESCARPMENT	C	C	C	C	(1)	P	P	P	P	P	C	C	C	C	N
FOREST, LOWLAND	C	C	C	C	C	P	P	P	P	P	C	C	C	C	N
FOREST, UPLAND	C	C	C	C	C	P	P	P	P	P	C	C	C	C	N
FOREST, CONIFEROUS*	C	C	C	C	(1)	P	P	P	P	P	C	C	C	C	N
FOREST, DECIDUOUS*	C	C	C	C	(1)	P	P	P	P	P	C	C	C	C	N
FOREST, DECIDUOUS/CONIFEROUS*	C	C	C	C	(1)	P	P	P	P	P	C	C	C	C	N
GLACIAL LAKE, BED	C	C	C	C	C	P	P	P	P	P	C	C	C	C	N
GROUND MORAINE	C	1	C	C	(1)	P	P	P	P	P	P	(1)	C	C	N
INTERCHANGES	C	C	C	C	C	P	P	P	P	P	C	C	C	C	N
LAKES	2	2	3	(3)	3	P	P	P	P	P	2	2	3	(3)	N
LAKE MICHIGAN	2	2	3	(3)	3	P	P	P	P	P	2	2	3	(3)	N
LAKES, LESS 50 ACRES	2	2	3	(3)	3	P	P	P	P	P	2	2	3	(3)	N
LIMITED ACCESS HIGHWAY	1	1	C	C	(1)	P	P	P	P	P	1	(1)	C	C	N
MARSH*	C	C	1	1	(1)	P	P	P	P	P	P	2	3	(3)	N
OPEN SWAMP	C	C	1	1	(1)	P	P	P	P	P	P	2	3	(3)	N
RESIDENTIAL, RURAL	2	3	C	C	(3)	P	P	P	P	P	P	(3)	C	C	N
RESIDENTIAL, SUBURBAN	1	2	C	C	(2)	P	P	P	P	P	P	(2)	C	C	N
RESIDENTIAL, URBAN	3	3	C	C	(3)	P	P	P	P	P	2	(3)	C	C	N
RIVERS	2	2	3	(3)	3	P	P	P	P	P	2	2	3	(3)	N
RIVER OR LAKE ZONING	2	2	3	(3)	3	P	P	P	P	P	2	2	3	(3)	N
ROADS	2	3	C	C	(3)	P	P	P	P	P	P	(3)	C	C	N
SAND DUNES	C	C	C	C	C	P	P	P	P	P	C	C	C	C	N
SHRUB CARR*	C	C	C	(1)	1	P	P	P	P	P	C	C	C	C	N
STREAM	C	C	C	C	C	P	P	P	P	P	C	C	C	C	N
STREAM, INTERMITTENT	C	C	C	C	C	P	P	P	P	P	C	C	C	C	N
TERRACES	C	C	C	C	C	P	P	P	P	P	C	C	C	C	N
UTILITIES - RAILWAY LINES	C	C	C	C	C	P	P	P	P	P	C	C	C	C	N

Data Stored in REMAP I and II Data Banks

Code: Data Can Be Identified

Data Item Identified with Difficulty...	1
Data Item Identified.....	2
Data Item Readily Identified.....	3
Image Format Most Appropriate for Identification	(#)

Data Cannot Be Identified

Quality Too Poor for Identification (Resolution, Cloud Cover).....	P
Not Available.....	N
Data Item Cannot be Identified.....	C

Date/% Cloud Cover	Oct. 2				20%	Oct. 20				30%	Nov. 7 /				-
	4	5	6	7	C	4	5	6	7	C	4	5	6	7	C
AGRICULTURAL	3	(3)	C	C	N	3	(3)	C	C	N	N	N	N	N	N
BEACH RIDGE	C	C	C	C	N	C	C	C	C	N	N	N	N	N	N
COMMUNICATIONS, AIRFIELDS*	3	(3)	C	C	N	3	(3)	C	C	N	N	N	N	N	N
DRUMLINS	2	(2)	1	1	N	2	(2)	1	1	N	N	N	N	N	N
END MORAINE	2	(2)	C	C	N	2	(2)	C	C	N	N	N	N	N	N
ESKER	C	C	C	C	N	C	C	C	C	N	N	N	N	N	N
ESCARPMENT	C	C	C	C	N	C	C	C	C	N	N	N	N	N	N
FOREST, LOWLAND	C	C	C	C	N	C	C	C	C	N	N	N	N	N	N
FOREST, UPLAND	C	C	C	C	N	C	C	C	C	N	N	N	N	N	N
FOREST, CONIFEROUS*	C	C	2	(2)	N	C	C	2	(2)	N	N	N	N	N	N
FOREST, DECIDUOUS*	C	C	2	(2)	N	C	C	2	(2)	N	N	N	N	N	N
FOREST, DECIDUOUS/CONIFEROUS*	C	C	2	(2)	N	C	C	2	(2)	N	N	N	N	N	N
GLACIAL LAKE, BED	C	C	C	C	N	C	C	C	C	N	N	N	N	N	N
GROUND MORAINE	1	(1)	1	1	N	1	(1)	1	1	N	N	N	N	N	N
INTERCHANGES	C	C	C	C	N	C	C	C	C	N	N	N	N	N	N
LAKES	2	2	3	(3)	N	3	3	3	(3)	N	N	N	N	N	N
LAKE MICHIGAN	3	3	3	(3)	N	3	3	3	(3)	N	N	N	N	N	N
LAKES, LESS 50 ACRES	3	3	3	(3)	N	3	3	3	(3)	N	N	N	N	N	N
LIMITED ACCESS HIGHWAY	2	(2)	C	C	N	2	(2)	C	C	N	N	N	N	N	N
MARSH*	1	1	3	(3)	N	1	1	3	(3)	N	N	N	N	N	N
OPEN SWAMP	1	1	3	(3)	N	1	1	3	(3)	N	N	N	N	N	N
RESIDENTIAL, RURAL	2	(3)	C	C	N	2	(3)	C	C	N	N	N	N	N	N
RESIDENTIAL, SUBURBAN	2	(3)	C	C	N	2	(3)	C	C	N	N	N	N	N	N
RESIDENTIAL, URBAN	2	(3)	1	1	N	2	(3)	C	C	N	N	N	N	N	N
RIVERS	1	1	3	(3)	N	1	1	3	(3)	N	N	N	N	N	N
RIVER OR LAKE ZONING	1	1	3	(3)	N	1	1	3	(3)	N	N	N	N	N	N
ROADS	2	(3)	C	C	N	2	(3)	C	C	N	N	N	N	N	N
SAND DUNES	C	C	C	C	N	C	C	C	C	N	N	N	N	N	N
SHRUB CARR*	1	1	3	(3)	N	1	1	3	(3)	N	N	N	N	N	N
STREAM	C	C	C	C	N	C	C	C	C	N	N	N	N	N	N
STREAM, INTERMITTENT	C	C	C	C	N	C	C	C	C	N	N	N	N	N	N
TERRACES	C	C	C	C	N	C	C	C	C	N	N	N	N	N	N
UTILITIES - RAILWAY LINES	C	C	C	C	N	C	C	C	C	N	N	N	N	N	N

Data Stored in REMAP I and II Data Banks

Code: Data Can Be Identified

Data Item Identified with Difficulty...	1
Data Item Identified.....	2
Data Item Readily Identified.....	3
Image Format Most Appropriate for Identification	(#)

Data Cannot Be Identified

Quality Too Poor for Identification (Resolution, Cloud Cover).....	P
Not Available.....	N
Data Item Cannot be Identified.....	C

Date/% Cloud Cover	Nov. 25					Dec. 13			0%		Dec. 31				
	4	5	6	7	C	4	5	6	7	C	4	5	6	7	C
AGRICULTURAL	N	N	N	N	N	C	C	C	C	N	N	N	N	N	N
BEACH RIDGE	N	N	N	N	N	C	C	C	C	N	N	N	N	N	N
COMMUNICATIONS, AIRFIELDS*	N	N	N	N	N	C	C	C	C	N	N	N	N	N	N
DRUMLINS	N	N	N	N	N	3	3	3	(3)	N	N	N	N	N	N
END MORAINE	N	N	N	N	N	3	3	3	(3)	N	N	N	N	N	N
ESKER	N	N	N	N	N	1	1	1	(1)	N	N	N	N	N	N
ESCARPMENT	N	N	N	N	N	3	3	3	(3)	N	N	N	N	N	N
FOREST, LOWLAND	N	N	N	N	N	C	C	C	C	N	N	N	N	N	N
FOREST, UPLAND	N	N	N	N	N	C	C	C	C	N	N	N	N	N	N
FOREST, CONIFEROUS*	N	N	N	N	N	1	1	1	(1)	N	N	N	N	N	N
FOREST, DECIDUOUS*	N	N	N	N	N	1	1	1	(1)	N	N	N	N	N	N
FOREST, DECIDUOUS/CONIFEROUS*	N	N	N	N	N	1	1	1	(1)	N	N	N	N	N	N
GLACIAL LAKE, BED	N	N	N	N	N	C	C	C	C	N	N	N	N	N	N
GROUND MORAINE	N	N	N	N	N	2	2	2	(2)	N	N	N	N	N	N
INTERCHANGES	N	N	N	N	N	C	C	C	C	N	N	N	N	N	N
LAKES	N	N	N	N	N	1	1	1	(1)	N	N	N	N	N	N
LAKE MICHIGAN	N	N	N	N	N	3	3	3	(3)	N	N	N	N	N	N
LAKES, LESS 50 ACRES	N	N	N	N	N	C	C	C	C	N	N	N	N	N	N
LIMITED ACCESS HIGHWAY	N	N	N	N	N	C	C	C	C	N	N	N	N	N	N
MARSH*	N	N	N	N	N	3	3	3	(3)	N	N	N	N	N	N
OPEN SWAMP	N	N	N	N	N	3	3	3	(3)	N	N	N	N	N	N
RESIDENTIAL, RURAL	N	N	N	N	N	C	C	C	C	N	N	N	N	N	N
RESIDENTIAL, SUBURBAN	N	N	N	N	N	C	C	C	C	N	N	N	N	N	N
RESIDENTIAL, URBAN	N	N	N	N	N	3	3	3	(3)	N	N	N	N	N	N
RIVERS	N	N	N	N	N	C	C	C	C	N	N	N	N	N	N
RIVER OR LAKE ZONING	N	N	N	N	N	C	C	C	C	N	N	N	N	N	N
ROADS	N	N	N	N	N	C	C	C	C	N	N	N	N	N	N
SAND DUNES	N	N	N	N	N	C	C	C	C	N	N	N	N	N	N
SHRUB CARR*	N	N	N	N	N	3	3	3	(3)	N	N	N	N	N	N
STREAM	N	N	N	N	N	C	C	C	C	N	N	N	N	N	N
STREAM, INTERMITTENT	N	N	N	N	N	C	C	C	C	N	N	N	N	N	N
TERRACES	N	N	N	N	N	3	3	3	(3)	N	N	N	N	N	N
UTILITIES - RAILWAY LINES	N	N	N	N	N	C	C	C	C	N	N	N	N	N	N

Code:

Data Can Be Identified	
Data Item Identified with Difficulty...	1
Data Item Identified.....	2
Data Item Readily Identified.....	3
Image Format Most Appropriate for Identification	(#)

Data Cannot Be Identified	
Quality Too Poor for Identification (Resolution, Cloud Cover).....	P
Not Available.....	N
Data Item Cannot be Identified.....	C

Date/% Cloud Cover	Jan. 18/					Feb. 5 70%									
	4	5	6	7	C	4	5	6	7	C	4	5	6	7	C
AGRICULTURAL	N	N	N	N	N	P	P	P	P	P					
BEACH RIDGE	N	N	N	N	N	P	P	P	P	P					
COMMUNICATIONS, AIRFIELDS*	N	N	N	N	N	P	P	P	P	P					
DRUMLINS	N	N	N	N	N	P	P	P	P	P					
END MORAINE	N	N	N	N	N	P	P	P	P	P					
ESKER	N	N	N	N	N	P	P	P	P	P					
ESCARPMENT	N	N	N	N	N	P	P	P	P	P					
FOREST, LOWLAND	N	N	N	N	N	P	P	P	P	P					
FOREST, UPLAND	N	N	N	N	N	P	P	P	P	P					
FOREST, CONIFEROUS*	N	N	N	N	N	P	P	P	P	P					
FOREST, DECIDUOUS*	N	N	N	N	N	P	P	P	P	P					
FOREST, DECIDUOUS/CONIFEROUS*	N	N	N	N	N	P	P	P	P	P					
GLACIAL LAKE, BED	N	N	N	N	N	P	P	P	P	P					
GROUND MORAINE	N	N	N	N	N	P	P	P	P	P					
INTERCHANGES	N	N	N	N	N	P	P	P	P	P					
LAKES	N	N	N	N	N	P	P	P	P	P					
LAKE MICHIGAN	N	N	N	N	N	P	P	P	P	P					
LAKES, LESS 50 ACRES	N	N	N	N	N	P	P	P	P	P					
LIMITED ACCESS HIGHWAY	N	N	N	N	N	P	P	P	P	P					
MARSH*	N	N	N	N	N	P	P	P	P	P					
OPEN SWAMP	N	N	N	N	N	P	P	P	P	P					
RESIDENTIAL, RURAL	N	N	N	N	N	P	P	P	P	P					
RESIDENTIAL, SUBURBAN	N	N	N	N	N	P	P	P	P	P					
RESIDENTIAL, URBAN	N	N	N	N	N	P	P	P	P	P					
RIVERS	N	N	N	N	N	P	P	P	P	P					
RIVER OR LAKE ZONING	N	N	N	N	N	P	P	P	P	P					
ROADS	N	N	N	N	N	P	P	P	P	P					
SAND DUNES	N	N	N	N	N	P	P	P	P	P					
SHRUB CARR*	N	N	N	N	N	P	P	P	P	P					
STREAM	N	N	N	N	N	P	P	P	P	P					
STREAM, INTERMITTENT	N	N	N	N	N	P	P	P	P	P					
TERRACES	N	N	N	N	N	P	P	P	P	P					
UTILITIES - RAILWAY LINES	N	N	N	N	N	P	P	P	P	P					

APPENDIX 2

THE USE OF ERTS 1 DATA FOR THE INVENTORY OF CRITICAL LAND RESOURCES FOR REGIONAL LAND USE PLANNING

J. L. Clapp, R. W. Kiefer,
M. M. McCarthy and B. J. Niemann, Jr.

The University of Wisconsin[1]
Madison, Wisconsin

ABSTRACT

Computer-generated spatial and statistical comparisons of critical land resource data derived from conventional sources, RB-57 photographs, and ERTS images, for an eastern Wisconsin test site, suggest that certain critical land resource data can be mapped from ERTS images on a statewide basis. This paper presents one of the biotic resources, "wetlands", as an example of the use of ERTS imagery to inventory land resources.

1. INTRODUCTION

The ERTS-1 project members at the University of Wisconsin-Madison are investigating the application and use of ERTS imagery as a data source for regional and state resource planning. A variety of resources are being evaluated and examined to determine the potential for the detection and monitoring of these resources from satellite and high altitude platforms. Resources being evaluated for detection include major biotic communities, landform configurations, land and resource areas altered by man-induced activities (e.g., farming, extraction, urbanization, and power plant construction) and the monitoring of land activity changes. This paper presents one of the biotic resources, "wetlands", as an example of the use of ERTS imagery to inventory land resources. The inventory of wetlands is especially important because the Governor's Wisconsin Land Resources Committee has concluded that "wetlands" are a critical resource, and yet, as of this date, state and regional planners do not know, in a quantitative sense, the location or extent of the State's wetland resources.

2. WETLANDS INVENTORY

To determine the effectiveness of the ERTS sensors for resource

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[1]Environmental Monitoring and Data Acquisition Group, Institute for Environmental Studies; Environmental Awareness Center, Department of Landscape Architecture; and Department of Civil and Environmental Engineering.

detection and inventory, a sample site in eastern Wisconsin is being utilized. This 10 x 30 kilometer "Sheboygan Test Site", shown in Figure 1, is part of a larger (10,000 square kilometer) test site generally located between Green Bay and Milwaukee, Wisconsin. The variable "open swamp" in the 10,000 cell, computer-based REMAP I (Regional Environmental Mapping and Analysis Process) data bank can be used as a measure of "wetlands" distribution in the study area. The REMAP I data bank was developed to assist the Wisconsin Department of Transportation locate a corridor for Interstate 57 and is serving as a comparison basis for the ERTS-1 investigation. "Open Swamp" can be defined as areas of wetlands occupied by such biotic communities as those dominated by grasses, sedges, emergent aquatics, dogwoods, shrub-willows, and alders. Such communities are variously called bogs, wet meadows, marshes, or swamps.

Figure 6 is a computer-processed spatial comparison which presents quantitative information about the occurrence of "open swamp" in the Sheboygan Test Site, as derived from 3 different sources: (A) ERTS-1 multispectral imagery; (B) RB-57 high altitude color infrared photography; and (C) the REMAP I data bank. Each cell shown in this sample site is one square kilometer in size, referenced according to the UTM system. The density of the symbol printed in each cell shows the percentage of that cell occupied by "open swamp" (blank = 0%; "." = 1-9%; "," = 10-19%; etc.). Beneath each 300 square kilometer area shown on Figure 6 is given the total acres of the variable "open swamp" as determined from each of the three data sources. Numbers of occurrence and numbers of acres for each of the three types of data source (A, B and C) are presented for each level of occurrence.

The information derived from ERTS imagery was interpreted from two different dates examined concurrently - 14 September 1972 and 13 December 1972. Figure 3 shows an ERTS image (9 August 1972) of most of the REMAP I data bank area with the 10 x 30 kilometer Sheboygan Test Site outlined. Figures 4 and 5 show examples of ERTS imagery from 9 August 1972 and 13 December 1972 for this test site. In examining the four MSS bands, the images produced by Band 5 were found to present the most information for this particular variable for the dates data were available.

Information from the RB-57 photographs was interpreted from color infrared positive transparencies taken in September 1971 (September has been found to be a superior time for photo interpretation of many vegetational communities in this region). An example of RB-57 photography for the test site is shown as Figure 2.

"Open swamp" as it exists in the REMAP I data bank was obtained from two sources: (1) Borgner land cover survey maps, and (2) interpretation of small-scale panchromatic aerial photographs. The Borgner studies represent the most complete inventory of vegetational resources for the entire state of Wisconsin. They were ground studies done during the 1930's in which species types and communities identification were made.

While some areas of the state have been studied more recently (e.g., Menominee County), no other data source exists for the state as a whole. The Borgner studies were supplemented with interpretations from black and white aerial photographs in an attempt to update the Borgner maps.

Figure 6 illustrates certain differences in the spatial distribution of the variable "open swamp" as derived from the three data sources. The most conspicuous difference is in the total numbers of acres of open swamp accounted for as interpreted from each data source: 2673 acres from ERTS 1; 2248 acres from RB-57; and 5002 acres in REMAP I data bank. From preliminary investigations (ground studies and re-check of interpretations), it is our conclusion that the ERTS and RB-57 derived data are a closer approximation of the location and extent of the wetland resource in the test site than the data now stored in the REMAP I data bank. The REMAP I data represent the best existing data as derived from conventional data sources. These REMAP I data are less valid than ERTS and RB-57 data for two reasons: (1) many areas that were wetland communities in the 1930's when the Borgner maps were compiled have disappeared, and (2) the data sources used were conducive to generating errors. These errors exist in both the original Borgner studies (now generally recognized by Wisconsin ecologists as being of limited value) and in extraction and classification errors when using small-scale panchromatic photographs as a data source for interpretation. Many lowland forest areas were incorrectly coded as wetlands and account for the larger total number of acres of "wetlands" stored in the REMAP I data bank. Such classification errors were <u>not</u> made during interpretations from ERTS-1 or RB-57 data because: (1) the data were of recent vintage (1971-72), and (2) the interpreters were able to differentiate well between lowland forest and open swamp. In the case of interpretations from RB-57 color infrared photographs (September 1971), community distinctions were possible because many plants were entering dormancy. In the case of interpretations from ERTS images, these distinctions were possible by means of an examination of two dates of imagery (September and December).

In comparing the ERTS-derived data with the RB-57-derived data, both the spatial results and the numerical quantities are as expected. It appears that certain small wetland areas (e.g., less than 10% of a cell) can be recognized on RB-57 photographs but cannot be identified on the ERTS images due to resolution limitations. Resolution and edge definition characteristics appear to influence an interpreter into perceiving higher percentile levels (percents of cell classified as open swamp) on ERTS images than on RB-57 photographs.

It is important to note that the delineating of wetlands, their extent and degree of occurrence, is only the first step in a resource inventory. Eventually, questions of wetland diversity, wetland quality, amount of biotic habitat, and similar concerns must be quantified. Many of these questions can be approached with RB-57 photographic data. ERTS data offer the advantage of sequentiality and can also exist in a number of formats.

As previously mentioned, we are investigating a variety of resources to determine the potential for the detection and monitoring of these resources from satellite and high altitude platforms. Initially, 15 resource types have been mapped for the Sheboygan Test Site and another 300 square kilometer test site near Green Bay. Computer calculations and spatial printouts, such as shown in Figure 6, have been prepared for these 15 resource types. The results obtained for "Forest" and "Agriculture" have been especially promising. They show (for the Sheboygan Test Site):

	Total Acres (A) ERTS	Total Acres (B) RB-57	Total Acres (C) REMAP I
Forest	11,992	14,507	12,599
Agriculture	45,352	44,830	48,894

3. SUMMARY

Effective regional and state land resource planning are dependent upon relevant information which presently may not exist, except in inaccurate or archaic forms. Also critical, for use by state and regional planners, is resource information at varying scales, including land resource information for citizen educational purposes, large area planning (e.g., power plant sites), public facility planning (e.g., controlled access highways), and information for legislation and control of land resources. As presented in this paper, the detection, inventory and monitoring of wetland resources appears feasible for the scales of planning just described, except for legal control (which requires accurate property description). Importantly, it was shown in this paper that ERTS-interpreted information in the case of wetland resources was more descriptive and accurate than the current statewide information sources. For the detection of the wetland resources as overall patterns, the ERTS images appear comparable to RB-57 photographs as a data source.

With the coming advent of statewide planning systems, such as New York's LUNR and Minnesota's MLIS, plus the need to inventory specific resources, the extent of applicability and usefulness of satellite sensors will be tested. Definitions and data resolution levels of resource information are being established by planning and governmental agencies. In the State of Wisconsin, for example, the State is implementing a Critical Resource Information Program (CRIP) aimed at establishing definitions, units of measurement, inventory, and monitoring of critical land resources for planning and legislative purposes. The desire and need to inventory and monitor land resources during the coming decade is obvious and the extent of applicability of ERTS satellite sensors will be of utmost interest to members responsible for and interested in the land resource planning and decision processes.

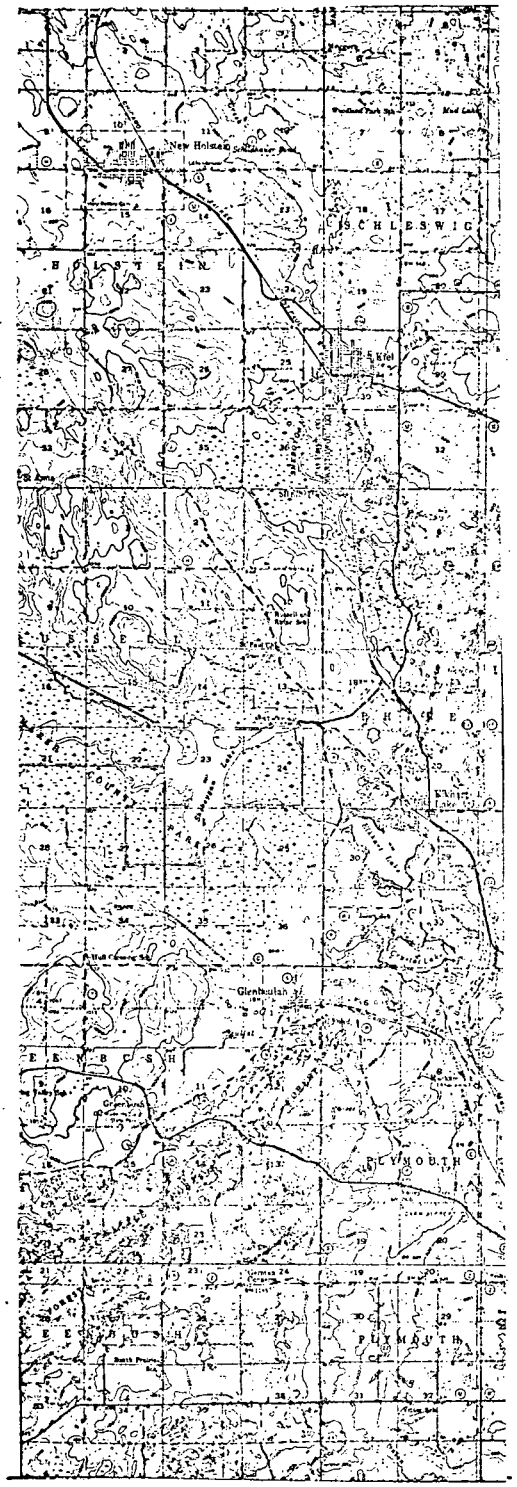

FIGURE 1

U.S.G.S. TOPOGRAPHIC MAP
10x30 km SHEBOYGAN TEST SITE

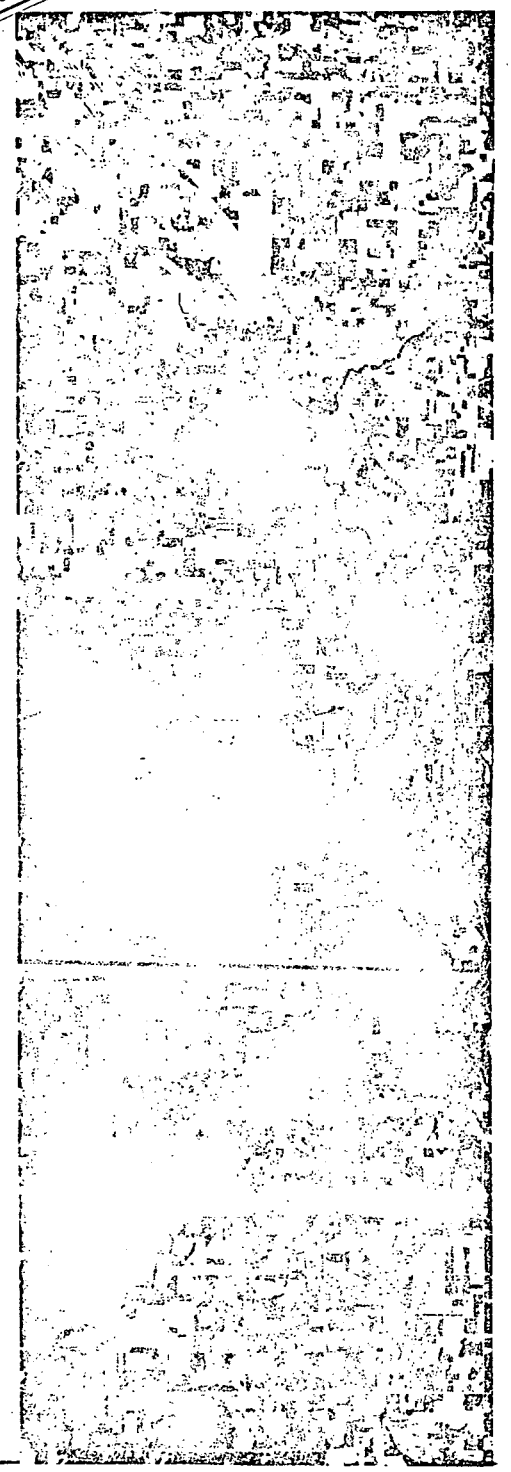

FIGURE 2

RB-57 PHOTO, 4 June 1972
Hasselblad, b/w red band

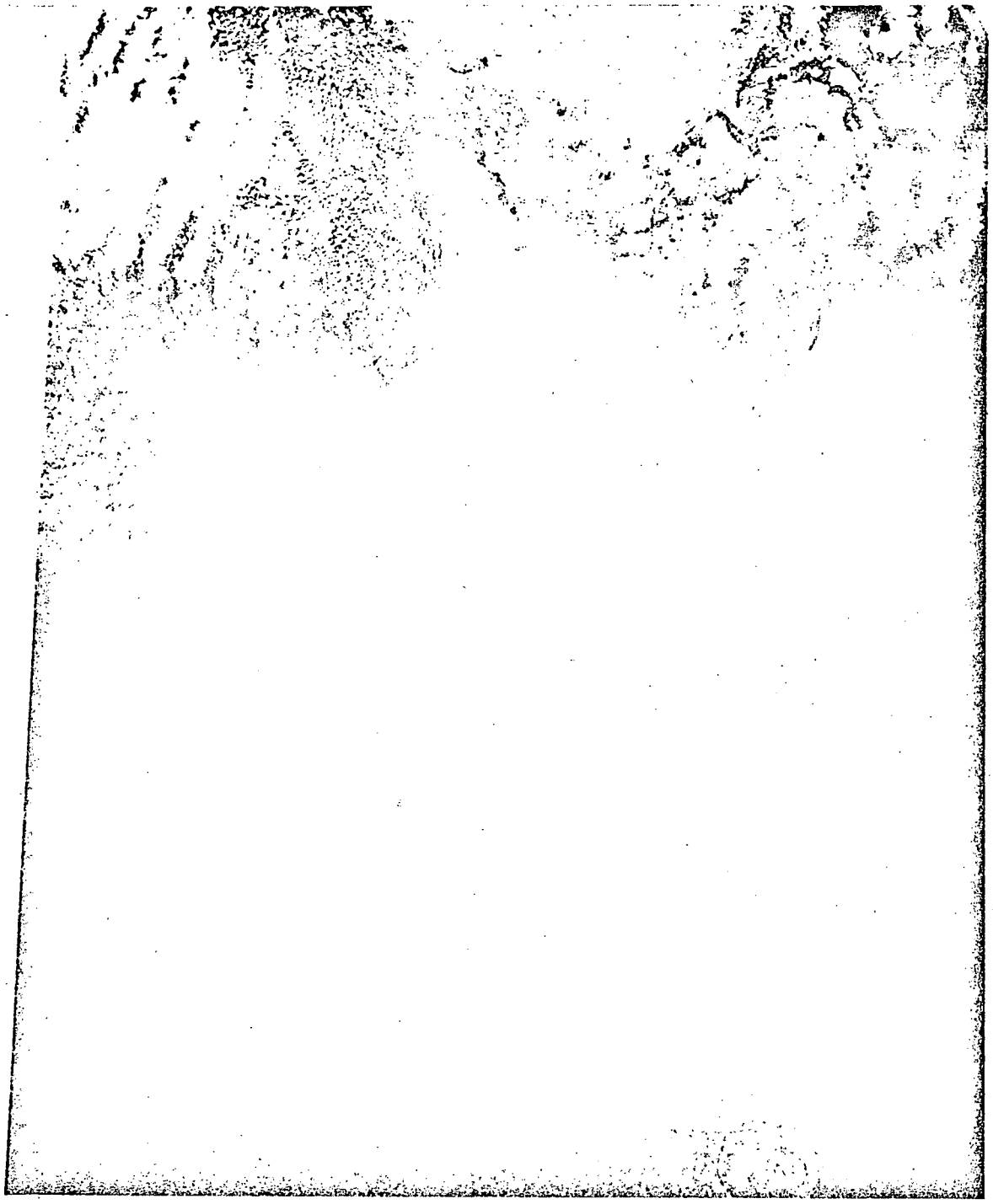

FIGURE 3 - ERTS BAND 5 (MSS-red), August 9, 1972
GREEN BAY-MILWAUKEE REGION

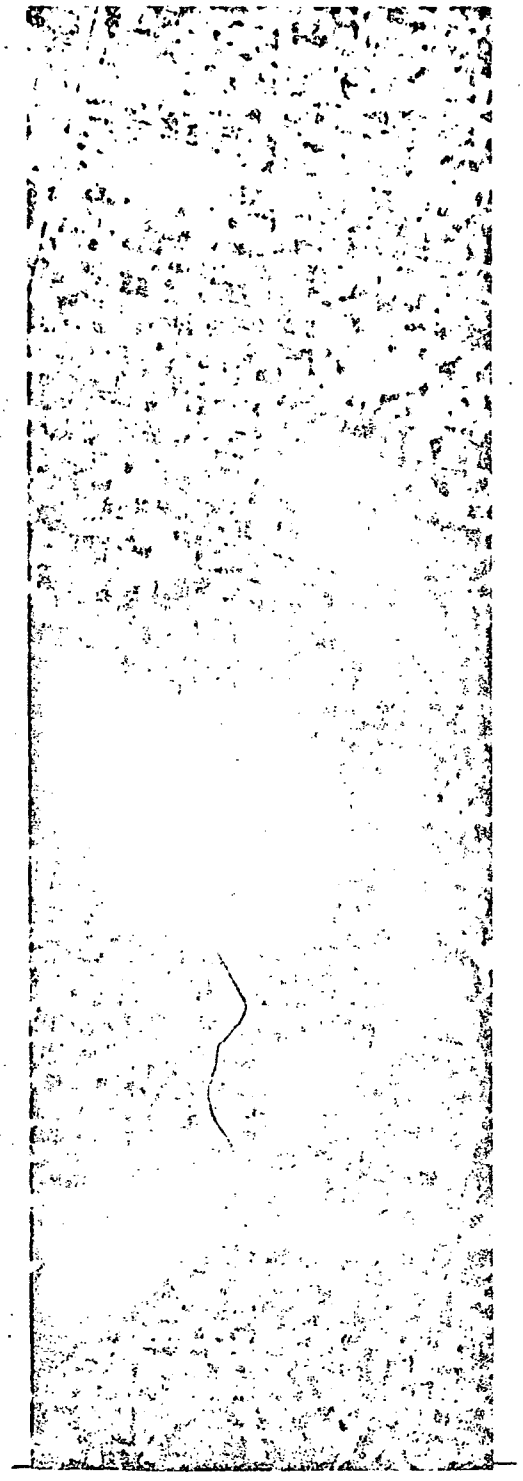

FIGURE 4

ERTS BAND 5 (MSS-red)
9 August 1972

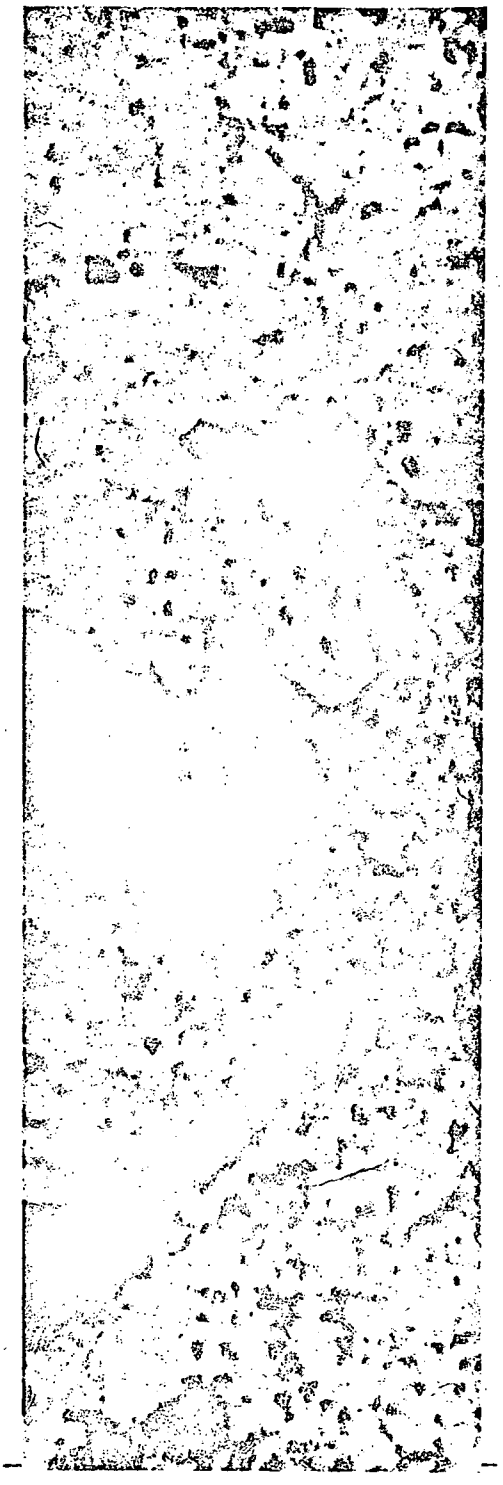

FIGURE 5

ERTS BAND 5 (MSS-red)
13 December 1972

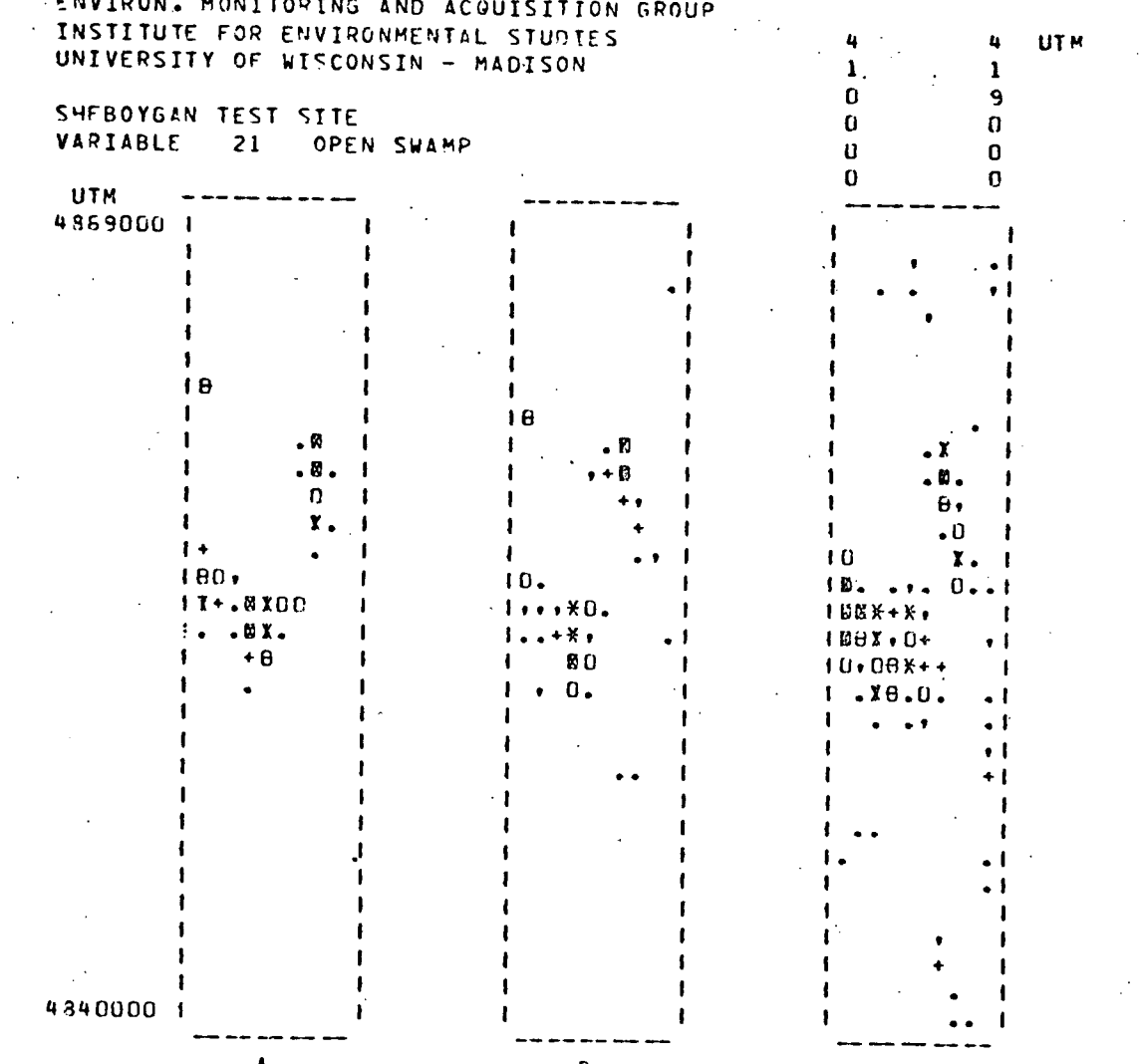

FIG. 6 WETLANDS (REMAP I VARIABLE "OPEN SWAMP")
ERTS and RB-57 INTERPRETATIONS vs REMAP I DATA BANK

APPENDIX 3

ERTS IMAGE DESCRIPTOR FORM

(See Instructions on Back)

NDPF USE ONLY
D
N
ID

DATE 1 April 1973

PRINCIPAL INVESTIGATOR James L. Clapp

GSFC UN 040

ORGANIZATION University of Wisconsin

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
101716091B				Agriculture
1053160905				Airfields
101716091B				Algal Bloom
101716091B				City/Metropolitan Area
1144161607				Dendritic Drainage
1143161027				Drumlin
1143161027				End Moraine
1144161517				Forest
1143160957				Frozen Lake
1143160957				Ice
101716091B				Lake
102016252B				Current
103716195B				Eddy
103716195B				Mud
112416050B				Harbor
103716195B				Runoff
107116095B				Sediment

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

MAIL TO ERTS USER SERVICES
CODE 563
BLDG 23 ROOM E413
NASA GSFC
GREENBELT, MD. 20771
301-982-5406

GSFC 37-2 (7/72)

APPENDIX 4

NDPF USE ONLY

D _____
N _____
ID _____
DTM _____
TM _____
TM APP. _____

ERTS DATA REQUEST FORM
560-213 (7/72)

1. DATE 6 March 1973

2. USER ID UN 040

4. SHIP TO:

ADDRESS J.L. Clapp ☐ NEW
1204 Engineering Bldg.
University of Wisconsin
Madison, Wisc. 53706

5. TELEPHONE NO. 608-262-1978 ☐ NEW

6. CATALOGUES DESIRED

STANDARD ☐ U.S. ☐ NON-U.S.

DCS ☐

MICROFILM ☐ U.S. ☐ NON-U.S.

ADDDHHMMS OBSERVATION IDENTIFIER	C CENTER POINT COORDINATES	B SENSOR BAND	P PRODUCT TYPE	F PRODUCT FORMAT	T TICK MARKS	NN NUMBER OF COPIES	A AREA
1017-16091	N43-54 W87-54	7	D	9		1	U
1143-16095	N44-26 W87-46	7	D	9		1	U
1053-16090	N44-32 W87-41	7	D	9		1	U
1053-16093	N43-07 W88-14	7	D	9		1	U